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VOLUME 121 NUMBER 3148

Government and the Freedom of Science: *J. T. Edsall* 615

National Academy of Sciences: *Abstracts of Papers Presented at the Annual Meeting* 619

News and Notes

Scientific Abstracting in the U.S.S.R.; and Regular Departments 627

Book Reviews

Optics; The Psychology of Invention in the Mathematical Field; The Theory of the Photographic Process; Principles of Geomorphology; The Alkaloids: Chemistry and Physiology; Organic Analysis; Books Reviewed in *The Scientific Monthly*; New Books; and Miscellaneous Publications 636

Technical Papers

Anomalous Structure in the Hypocotyl of Soybean Following Treatment with 2,4-Dichlorophenoxyacetic Acid: *C. N. Sun* 641

Genetic and Nongenetic Effects of Radiations in *Neurospora*: *V. W. Woodward* and *C. M. Clark* 641

Liquid Sulfur Dioxide as a Solvent for Proteins and the Infrared Spectrum of Proteins in Solution: *J. J. Katz* 642

Auxin Gradient Theory of Abscission Regulation: *F. T. Addicott, R. S. Lynch, H. R. Carns* 644

Communications

Educators Sampled from an Undefined Population: *J. C. Stanley* and *P. Thomasson* 645

Change in pK'_a of Representative Compounds with Solvent Composition: *J. M. Vandenbelt* et al. 646

More on Contemporary Science and the Poets: *H. D. Hammond*; *J. Z. Fullmer* 647

Science and Policy 5A

Meetings & Conferences 7A

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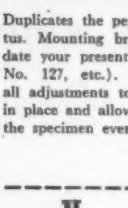

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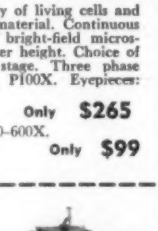

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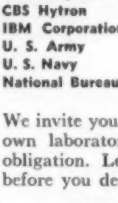

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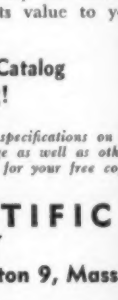

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Government and the Freedom of Science

John T. Edsall

Biological Laboratories, Harvard University, Cambridge, Massachusetts

THE vast growth of the support of scientific research by Government has given the Government great powers over the careers of scientific investigators. On the whole, these powers have been used thoughtfully and with restraint by enlightened administrators who have worked in close collaboration with the scientists themselves. However, a serious threat to the freedom of the individual and to certain basic rights has arisen lately. Research grants for unclassified research by men of high competence and generally unchallenged integrity have been withheld, or abruptly revoked, because of unspecified allegations of supposedly subversive activities. Therefore all scientists must welcome both the recent request from Sherman Adams, Assistant to the President, to Detlev W. Bronk, that the National Academy of Sciences take the problem under consideration, and Bronk's prompt acceptance of this responsibility on behalf of the Academy (*1*).

The issues involved are grave; they have aroused widespread concern among the members of the scientific community of the United States. Yet there has been little public discussion of the issues and apparently no attempt at explicit formulation of principles. We may have confidence that the National Academy Committee (*2*) that is to deal with the problem will face the issues wisely and forthrightly. Yet committees like this one can operate effectively only on the basis of informed and thoughtful opinion diffused generally among American citizens, especially those of the scientific world. As one of these citizens, I have set down the following considerations, formulated gradually during many months of study and discussion with colleagues (*3*). Certainly I claim no special wisdom or insight. Whatever may be of value in this discussion is only a reaffirmation of principles long formulated and long honored but apparently often forgotten in the stress of the atmosphere of crisis in which we live today.

We must first be explicit with regard to where most of the trouble has occurred. More than one Government agency has been involved in actions of the type I am discussing; but the most numerous and most serious incidents have been related to research supported by the U.S. Public Health Service. During the last decade, the Public Health Service has established a splendid record of achievement in its program of research grants and fellowships, which have been administered with wisdom, and with respect and understanding for the conditions required by scientific men to achieve the best that is in them. In the early spring of 1954, however, reports began to circulate that grants for open, unclassified research were being revoked or denied, on grounds apparently political and unconnected with the competence or integrity of the investigators involved. A statement of the policy involved was made by Oveta Culp Hobby, Secretary of the Department of Health, Education, and Welfare, on 28 April 1954. This was published at the time in several newspapers and has since been circulated by the Federation of American Scientists. The most relevant paragraphs follow.

> We do not require security or loyalty investigations in connection with the award of research grants. When, however, information of a substantial nature reflecting on loyalty of an individual is brought to our attention, it becomes our duty to give it more serious consideration. In those instances where it is established to the satisfaction of this Department that the individual has engaged or is engaging in subversive activities or that there is serious question of his loyalty to the United States, it is the practice of the Department to deny support.
>
> If the subject is an applicant, the grant is not awarded. If the subject is an investigator responsible for a grant-supported project or is the recipient of salary from the grant, the grant is terminated unless the sponsoring institution desires to appoint an acceptable substitute.
>
> The Public Health Service supports a large segment of medical and related research through more than 2,000 grants which involve some 14,000 persons each year. Although this practice has been followed since June, 1952, fewer than 30 persons have been denied support.

We may note that the policy, for which Secretary Hobby has taken responsibility in this statement, was not initiated by her, for its beginning in June 1952 antedates the present Administration in Washington. This point is mentioned to emphasize that the issues I am discussing may be considered apart from party politics.

The actions described in Secretary Hobby's statement had already aroused deep concern among scientists. For instance, on 15 April 1954, the American Society of Biological Chemists adopted a resolution strongly protesting such actions and requesting the National Academy of Sciences to investigate the situation. Similar action was later taken by the American Physiological Society (*4*) and by other scientific societies and groups. These protests and the vigorous action of the authorities of the National Academy in pursuing the problem have certainly played a major part in bringing about the inquiry that the National Academy Committee has been asked to undertake.

Secretary Hobby's announcement is not a statement of what might happen; it is a statement of what has happened and what is continuing to happen. It was acknowledged in the statement itself that nearly 30 investigators had been affected by this ruling. Others—I do not know how many—have been affected since. In

some cases the action taken involves the refusal to award or to renew a grant, on grounds unconnected with the scientific qualifications of the investigator or with his personal integrity and character, as such terms are commonly understood by ordinary men. In other cases the action has been more drastic: it has involved the sudden revocation of a grant already awarded and approved, sometimes in the midst of a 3- or 5-year term of support. Action has been taken suddenly, perhaps with a month's notice, after which all funds were cut off. Explanation for the action has been refused, but a double blow has been dealt the investigator involved. First, he has been deprived of funds vital to his research, often on extraordinarily short notice. Second, the action could be taken by some as implying something dubious, possibly something sinister, concerning the investigator's past. These implications are there; they are intangible; nothing is revealed; no opportunity is given to the investigator to know the nature of the implied charges or to offer any reply. The revocation of funds, under such circumstances, can threaten his future career and make other agencies reluctant to support his work. If he is in a position that lacks tenure, it may even threaten the loss of his job. It may be said that the careful avoidance of publicity that has been maintained in these matters is a protection for the individual involved. However, when the investigator turns to another agency to seek support, the fact that a grant has been revoked or denied must almost inevitably appear, and the potential threat to his future career will arise in acute form.

It should be reiterated here that the research for which these men have been granted funds is not secret in any way. No threat to national security is involved in their pursuing their work openly. They are charged with no offense against the law. The action taken against them has often involved the breaking of a moral agreement, if not a legal contract, by the supporting agency. The action is taken outside the security system and outside the law, in a no man's land of undefined accusations and vague suspicions.

A fundamental distinction between open and classified research must be emphasized. Virtually all of us acknowledge the necessity of a security system whenever secret work is involved. In the present troubled state of the world—a condition which is neither peace nor war and which has no earlier parallel in the experience of most of us—some such system is indeed a somber necessity. The rigorous requirements of security inevitably involve at times the barring of highly qualified individuals from access to secret information, if there is any reason for substantial doubt concerning their loyalty or discretion. On occasion the decision must be taken to deny the individual such access, even though in fact he may be completely loyal and trustworthy. If the system is wisely administered, such cases should be rare.

The application of the rules is not simple; the value of employing an unusually gifted individual must be balanced against the risks involved in his employment; for every person is to some extent a security risk. The general principles, however, are clear, and they differ in at least one fundamental respect from the principles of the law. The assumption that an individual is innocent until proved guilty cannot be taken over directly into the security system. To work under that system is a privilege, not a right, and individuals may on occasion be rejected on suspicion, even if those suspicions are unfounded. We may grant these general principles underlying the operation of the security system, but at the same time we may raise grave questions regarding the wisdom with which they have been applied in specific cases. Overzealous application of the rules, resulting in the exclusion of highly qualified individuals from service to their country for inadequate reasons, may in itself be one of the greatest of security risks.

Withholding unclassified research grants on the basis of undisclosed information, however, is a policy that raises totally different issues. It is, in effect, an intrusion of the security system into a realm that has nothing to do with security. Security considerations are a painful necessity; we accept them as having compelling force within the area where secrecy must prevail. They are irrelevant and dangerous when invoked outside that area.

Whether he operates under the security system or not, every person is subject to the law. If he has engaged in criminal subversive activities he is subject to trial and to punishment. Such activities, when they exist, are indeed frequently so cloaked in secrecy that it may be exceedingly difficult to obtain the evidence justifying a legal conviction, even when one may be convinced that the individual is actually guilty. Such criminal activities, however, must be sharply distinguished from expressions of opinion, no matter how repulsive the opinions may appear to most of us.

For the most part, the identity of the persons who have been denied support for unclassified research is unknown to me. I have learned the names of three or four of them, however, and they are men whom I know well. They are outstanding in their fields of research. They have made major contributions to our understanding of such subjects as the structures of biological macromolecules, immunological reactions, and metabolic processes. They are admired, respected, and trusted by their scientific associates. Some of them in the past may have upheld political views that seem to me foolish or ill-judged, but these are matters that they are free to decide for themselves. I do not know one among my scientific colleagues who would question the integrity or character of these men or who would doubt in any way their suitability to receive support for open and unclassified research.

The damage done directly to these men by the policies of the U.S. Public Health Service is a serious matter. The actions taken are regarded as frankly outrageous by many, including myself. However, I submit that the gravest damage done by these policies is not to the men whose grants are withheld. The few whose names are known to me stand high in the esteem

of their colleagues; both they and we deeply resent the imputations cast upon them. As yet I know of none of them who has not been able to obtain support for his research elsewhere. This may not be true of all; some indeed, I am sure, fear that their ability to get support elsewhere is threatened. All this is bad, but the worst effects are upon other persons who continue to be approved and to receive support. Each one can picture himself also among those that are in trouble; even though he, himself, is in no danger, he may become more guarded in his speech; some thoughts that come to him he may not speak to his colleagues as freely as before, hesitating now and then lest he may say something that might conceivably be used against him.

Two of my colleagues—men of great capacity, courage, and force of character—have told me they have found this attitude beginning to affect them. They granted that on rational grounds they had nothing to fear; they were clear in their consciences and in the eyes of the law; but they knew too well the obscure nature of the grounds on which support had been denied to others; they feared for the younger people working in their departments, whose future could be imperiled by the denial of support, and they became more cautious because of this anxiety. Such fears are destructive. The struggle to guarantee to all men the right to speak their minds on controversial issues without fear of reprisals has gone on for centuries. That right is always in jeopardy and it must be constantly and actively maintained. It is certainly vital for scientific workers, to whom independent thinking is a basic necessity in their work.

These fears are supported by indications that information from anonymous accusers is being used as a ground for disqualifying individuals from holding grants from the Government. The actions taken have been so carefully cloaked in secrecy that it is nearly impossible for a private individual to know what has been done. However, evidence from anonymous accusers, not speaking under oath, was employed against John P. Peters in the hearing that led to his removal as a special consultant to the Public Health Service. In the words of an editorial in the *Washington Post and Times Herald* on 29 Nov. 1954 (*5*), the work of Peters "involved no access to confidential or strategic information." Several eminent men—Charles W. Seymour, former president of Yale, Charles E. Clark, judge of the Second Circuit Court of Appeals, and C. N. H. Long, former dean of the Yale Medical School—testified under oath on Peters' behalf. Yet the verdict given upheld the anonymous hostile informants, the identity of all but one of whom was unknown even to the board that passed on the case.

The case of Peters is still under consideration by the Supreme Court, and it would be impertinent to express an opinion in advance concerning what the verdict should be. Let us tentatively make the assumption that the Supreme Court will hold that Government has been acting within its rights in removing Peters from his position. I would still hold that Government, even if it has these powers, should refrain from exercising them except for grave reasons of national security. If a man has access to secret and vital information or if he is in a position in which he might endanger national security by sabotage during a crisis, then accusations against him from any source must be carefully weighed. They must be weighed with caution—a skillfully worded anonymous accusation, framed by a clever Communist agent, could be a powerful weapon in disqualifying a loyal and gifted scientist from serving his country in a sensitive position. Nevertheless, when national security is involved, such warnings cannot be disregarded. If a man working under the security system is removed from his post because of anonymous charges made against him, this need not imply guilt of any sort; it merely means that there is considered to be a risk in his employment in a sensitive post, a risk that the responsible authorities do not feel justified in taking.

For a man who operates outside the security system, however, the usual standards of our law and our society should prevail. If such a man is trusted and respected by his colleagues and neighbors, if they testify to his integrity, anonymous accusations should be ruled out of consideration in relation to his fitness to receive a grant for open research. It is a dirty business to make such accusations or to lend an ear to them when they are made; they poison the straightforward trust in dealings between men, which is the normal basis on which scientists, like most other people, carry on their work together. To strike at this basis of trust is to sow suspicion and hostility, to weaken the coherence of our society, and thereby to damage the national security itself.

The policies attacked here violate a long tradition—a tradition deeply rooted in English and American law—extending far beyond the confines of the law as such. This tradition insists upon the right of the individual, if an accusation is lodged against him, to know the nature of the accusation and the identity of the accuser. One might attempt to evade the issue here by saying that there is no accusation—that the Government is free to grant or withhold funds as it pleases; that the receiving of funds for scientific research is a privilege, not a right, and that this privilege may be withdrawn at any time by the granting authority at its own discretion. We may admit that technically there is much truth in this. The Government may set the terms upon which it bestows these funds; if the proposed recipient disapproves the terms, he is free to refuse the proffered funds until the terms are altered. But our Government exists to serve the people, and it is my conviction that the people are not best served by offering money for basic scientific research on such terms as this. It is not enough, of course, for the scientists to be convinced of this fact; the ultimate decision is in the hands of the American people and many will not accept the point of view expounded here unless it is fully and carefully explained to them.

It is a matter of profound regret to me that the

policies that are here attacked have been formulated and applied by the U.S. Public Health Service, which has performed magnificent service during the years since the war in the support of fundamental research in the United States. Its policies have, in general, been admirable. Its administrators have shown an enlightened outlook in promoting fundamental research; and, apart from the lamentable issues here discussed, they have shown an admirable solicitude for the freedom of the investigator. The laboratory with which I have been associated for many years has received generous and understanding support from the Public Health Service, which has made possible a long series of researches with which I am proud to have been associated. All this I am happy to acknowledge. However, the recently developed policy of the U.S. Public Health Service with which I am concerned here, while ostensibly designed to oppose subversion, appears to me to be itself subversive—subversive of the traditional liberties of the individual and of his right to be judged by due process of law or by something analogous to due process in matters that do not lie strictly within the domain of the law.

Many will say that the issues involved are not as grave as I depict them; that very few people are being hurt; that these disturbances will pass; and that we may endanger the whole structure of Government support of science by challenging the procedures now being adopted. I reject such arguments. Certainly I do not share the fears of the alarmists who believe that our society is rapidly becoming totalitarian; the fact that articles like this one can be published and freely discussed is good disproof of such ideas. Yet the trend toward totalitarian procedures is present in the arbitrary actions that I have discussed; and the time for resistance is now, not later. The men who are enforcing the decisions I oppose are certainly not ruthless autocrats—they are probably conscientious administrators, worried about maintaining the flow of Government funds for science and fearful lest congressional investigators should charge some recipient of a Government grant with being a subversive character. All this is human and understandable, but I believe that it shows a dangerous timidity on the part of certain administrators and that it has done great harm. Even if only a few of our colleagues are hurt—whether it is one person or many—I believe that we should stand up and protest on their behalf. In any case the threat is not to a few persons only; it is to all of us; for no one knows whether or not he will be the next victim, and whether or not he will find his own support cut away and his own future in jeopardy.

Inevitably the decision concerning proper action in this grave situation is not easy for most scientists. Because I am not a department head, and because I derive my research support from other agencies that have maintained the tradition of freedom, I feel that I can speak more openly than many of my colleagues. I can say only that the withholding of research grants for unclassified research on grounds unconnected with the scientific competence and integrity of the investigator is abhorrent to me. Under the circumstances I shall neither ask for nor accept funds from any Government agency that denies support to others for unclassified research for reasons unconnected with scientific competence or personal integrity. If I do receive funds for research and I learn subsequently that the granting agency has adopted such a policy toward other individuals, I shall stop using such funds and shall return the unexpended balance to the agency that awarded them to me.

I state this as a personal policy without urging that my colleagues join me in it. I know many whose personal convictions are essentially identical with mine but who feel precluded from taking similar action because of their responsibility for obtaining funds for their departments and especially for the younger workers whose careers would be imperiled if funds were cut off. For myself, however, I can say only that I see great danger in the present situation. Having freedom to speak and holding the convictions that I do, I feel that I cannot keep silent in the face of a policy which I believe to be a threat both to the freedom of science and to the basis of the social order in which most of us believe.

Immensely powerful forces are transforming our society and the status of science and scientists within our society. For a vigorous modern nation, a flourishing science is a condition for national strength and even for survival. Scientists are urgently needed, and the pressure grows increasingly strong to consider the scientist as the servant of the state. Insofar as he operates under the security system, or in any case in which he serves as an adviser to Government, the scientist is indeed a servant of the state. It is imperative, however, to preserve, in spite of the portentous growth of the power of the state, the tradition of free scientific inquiry by persons who in their work owe no allegiance except to the spirit of inquiry, the desire to understand, and the sense of beauty in discerning patterns of order amid the chaotic multiplicity of phenomena. It is the independent, unfettered investigators who have made the great germinal discoveries, and if we do not provide the conditions in which such men can flourish, we shall lose leadership in science. Yet in our world of today such scientists, like others who work on problems of a more applied type, must receive much of the support for their work from Government. It is one of the great problems of our time to maintain a Federal Government that has at its disposal immense material resources and immense power, and still to insure that the power is used with due respect for the integrity of the individual and for his personal freedom. It is, I think, one of the great American achievements of the past generation that we have largely succeeded, during a period of profound social change, in combining these almost incompatible objectives. I believe that we can and must succeed in doing this in the field of Government support of sci-

ence. To succeed requires incessant vigilance to prevent undue encroachments on personal freedom and a patient determination that scientists and Government administrators cooperate and understand one another to make the system work.

References and Notes

1. *Science* **121**, 7A (11 Feb. 1955).
2. *Science* **121**, 490 (8 Apr. 1955).
3. A draft of this paper was sent to Oveta Culp Hobby, Secretary of the Department of Health, Education, and Welfare, on 23 Dec. 1954. The letter of acknowledgment stated that the problems discussed in the paper were being considered. On 27 Jan. 1955 I again wrote to Secretary Hobby asking whether the paper contained any misstatements about the U.S. Public Health Service. The reply mentioned none but stated that the problem was still under study. I then decided to submit the paper for publication, after revising the opening statement to take account of recent events and adding two paragraphs related to the use of anonymous informers.—J. T. E.
4. *Science* **120**, 1010 (17 Dec. 1954).
5. Reprinted in *Science* **120**, 1009 (17 Dec. 1954).

National Academy of Sciences

Abstracts of Papers Presented at the Annual Meeting

25–27 April 1955, Washington, D.C.

Localized Ultraviolet Irradiation of Parts of Chromosomes and of Cytoplasm in Dividing Cells

William Bloom, Raymond E. Zirkle, Robert B. Uretz, *University of Chicago*

Localized irradiation of small parts of chromosomes of mesothelial cells of newt (*Triturus viridescens*) with heterochromatic ultraviolet light produces a localized change of refractive index of the chromosomes, as is seen by phase-contrast microscopy in the living cells. The "pale" areas do not stain with ordinary nuclear stains or with the Feulgen method after fixation. Irradiation of equal amounts of cytoplasm during metaphase causes a collapse of the spindle and a subsequent "false anaphase" in which whole chromosomes aggregate in two clumps of random number. These clumps move apart and cytokinesis follows. Irradiation of cytoplasm during early prophase apparently inhibits development of the spindle but "false anaphase" nevertheless takes place.

We are testing the relative effectiveness of different wavelengths in producing these effects.

Progress in the Theory of Superconductivity

John Bardeen, *University of Illinois*

Considerable progress in understanding superconductivity has been made from both phenomenological and atomistic approaches, although difficulties remain. Magnetic properties can be accounted for by a model in which the ad hoc assumption is made that the electrons form a condensed superconducting state such that a finite energy $\varepsilon \sim kT_c$ is required to excite an electron. Otherwise, excited electrons in the superconducting phase are assumed to be similar to those of the normal phase.

The theory does not lead to the London equations but to phenomenological equations similar to those suggested by Pippard. The current density at a point is determined by the field in a region of $\sim 10^{-4}$ cm surrounding the point. A dependence of penetration depth on mean free path, as observed by Pippard, is a consequence of the theory. It has not yet been possible to derive this model from first principles.

Recently, Pines and Bardeen have shown why, as is indicated experimentally by the isotope effect, electron-lattice interactions are more important than Coulomb interactions in the normal-superconducting transition. This justifies the approach of Fröhlich and of Bardeen. The criterion for superconductivity is essentially that electron-lattice interactions be so large that they cannot be treated by perturbation theory. Satisfactory mathematical methods for treating such large interactions are lacking. It may be hoped that future developments will bridge the gap.

A Mono-acetyl Derivative of Chymotrypsin

Arnold Kent Balls, *Purdue University*

The question of the constitution of the active center of a hydrolytic enzyme has not yet received a satisfactory answer in any given case. One promising approach, however, appears to have been with chymotrypsin, whose inhibition by halogen phosphate esters results from the introduction of a single phosphoryl group into the enzyme molecule. For several reasons it seems likely that this group becomes attached to a part of the active center. The active center also appears to be clearly involved in the acetylation of chymotrypsin by *p*-nitrophenyl acetate, for the reaction occurs prior to a slow enzymatic decomposition of this substrate and consists in the transfer of one acetyl group to the enzyme molecule [Hartley and Kilby, *Biochem. J.* **56**, 288 (1954)].

While also studying this reaction, we have observed that it did not occur with chymotrypsinogen or with inactivated chymotrypsin. The acetylated protein was, moreover, inactive toward ordinary substrates. Chymotrypsin acetylated with ortho-, para-, or 2,4 dinitrophenyl acetate showed an unexpected stability in acid solution. By taking advantage of this property, it was possible to isolate the acetylated protein in apparently rather pure form. No rapid liberation of acid occurred when chymotrypsin reacted with a nitrophenyl acetate, but rapid liberation of acid did occur when a solution of the isolated protein was made slightly alkaline. The acetylated protein yielded one equivalent of a hydroxamic acid when treated with hydroxylamine at *p*H 6.5; thus the new substance appears to be unusually reactive. Reversion to chymotrypsin occurred rapidly in alkaline solutions. In a slightly acid

medium containing tyrosine ethyl ester (a substrate of chymotrypsin), practically no enzymic activity was found at first, but activity increased with time until eventually the entire activity of the original chymotrypsin had returned.

The resemblance between acetylated and phosphorylated chymotrypsin thus appears to be close, except for the great stability of the latter and the instability of the former.

Relativistic Formulation of Coulomb Scattering for Proton-Proton Collisions

Gregory Breit, *Yale University*

It is shown that the usual treatment of the collision process making use of Møller's formula (*1*) involves an inconsistency connected with the infinite cross section for small-angle scattering. A treatment of the collision process free of this objectionable feature has been devised. It is subject to the following limitations: (i) the expansion of the collision cross section in powers of e^2, the square of the electronic charge, is limited to the first term and is therefore restricted in applicability to high energies; (ii) the effect of inelastic processes such as meson production is neglected, a restriction to energies below ~ 400 Mev; (iii) effects of the anomalous proton magnetic moment are considered approximately only.

The treatment makes use of (i) the possibility of introducing phase shifts relativistically in the center of mass system in an unambiguous manner, (ii) a general connection between phase shift and energy changes (*2*), (iii) the possibility of ascertaining the first-order changes in energy (*3*). The results form a relativistic extension of the Mott-Gordon solution for nonrelativistic Coulomb scattering. They contain some previously unsuspected types of spin-orbit and tensorlike forces and agree in some respects with some considerations of Garren (*4*).

The treatment presented here is suitable for the addition of phase shift caused by specifically nuclear effects to the Coulomb phase shifts. This research has been assisted by the Office of Ordnance Research.

References: (1) C. Møller, *Z. Physik* **70**, 786 (1931); (2) G. Breit, *Revs. Mod. Phys.* **23**, 238 (1951); (3) ———, *Phys. Rev.* **34**, 553 (1929); (4) A. Garren, *ibid.* **36**, 1709 (1954).

Quantum Efficiencies of Photosynthesis and Cell Growth in Thermophilic *Chlorella* at High Light Intensities

Dean Burk, *Max Planck Institute for Cell Physiology, Berlin-Dahlem*
George Hobby and Jehu Hunter, *National Cancer Institute*

Maximal quantum efficiencies were measured with rapidly photosynthesizing and multiplying thermophilic *Chlorella* strain 7-11-05 (Sorokin and Myers, University of Texas). A method was developed for simultaneous measurement of O_2 production and CO_2 consumption (thus $\gamma = x_{-CO_2}/x_{-O_2}$) in a single manometric vessel, involving complete fixation of large, prearranged amounts of CO_2 (that is, 1000 μ lit), confirmable as several-fold cell volume increases during a day's run and by wet combustion.

At 39°C and pH 4.5 ± 1, with CO_2/air mixtures and optimal mineral nutrition, and with incident light intensities up to 10 to 15 microeinsteins per minute per beam of 10-cm² area (about 1000 to 1500 ft-ca) of light of $\lambda < 650$ mμ, the observed quantum requirement for positive oxygen production, uncorrected for notable losses in concurrent respiration and rapid growth, decreased from infinity at the compensation point to minimum values of 5 to 6 $h\nu/O_2$ at the upper part of the linear light-intensity response curves where the hourly volume of O_2 produced was 50 to 100 times the volume of cells, which were multiplying with a generation time as low as 4 hr, with maintenance of approximately constant chemical composition. Upon correction for energy expenditure losses necessarily involved in the measured, rapid growth (involving formation of numerous cell constituents, on the average more reduced than sugar, $\gamma = -0.95 \pm 0.05$) the estimated maximum quantum requirement for photosynthesis proper, in terms of N-free carbohydrate equivalent, approached the values of 3 to 4 $h\nu/O_2$ reported in recent years by Otto Warburg and coworkers for conventional nonthermophilic *Chlorella*, where rates of growth and photosynthesis are slower by nearly an order of magnitude. Clearly, the thermophilic *Chlorella* offer many advantages of theoretical and practical interest.

Relationship between Potassium Utilization and Nitrogen Balance

Paul R. Cannon, Laurence E. Frazier, Randolph H. Hughes, *University of Chicago*

Experiments were performed in normal and in protein-depleted rats in an effort to determine the metabolic interrelationships between positive and negative nitrogen balances and the capacity of the tissues to retain dietary potassium. When the animals were fed synthetic rations devoid of nitrogen and potassium, weight loss ensued, and nitrogen and potassium balances were negative. The administration of potassium chloride, while the rats were eating a nitrogen-free ration, failed to establish positive potassium balances or to engender weight gains, but the addition to the ration of a mixture of 16 amino acids caused the animals to go into both positive nitrogen and potassium balance. Following the elimination of one essential amino acid (tryptophan) from the ration, however, the animals went quickly into negative nitrogen and potassium balance. Finally, the feeding of the complete amino acid ration devoid of potassium led to the development of a positive nitrogen balance but a continued negative potassium balance.

These experiments emphasize the importance of anabolism in relation to the over-all utilization of dietary potassium. They suggest, also, that in the presence of a general catabolic state, tissue retention of dietary potassium is impaired and that, for optimal cellular utilization of potassium for purposes of tissue synthesis, the anabolic state is an essential requirement.

The Photosynthetic Cycle

Melvin Calvin, *University of California, Berkeley*

A cyclic sequence of transformation, including the carboxylation of RDP and its reformation, has been deduced as the route for the creation of reduced carbon compounds in photosynthetic organisms. With the demonstration of RDP as substrate for the carboxylation in a cell-free system, each of the reactions has been carried out independently *in vitro*. Further purification of this last enzyme system has confirmed the deduction that the carboxylation of RDP leads directly to the 2 molecules of PGA involving an internal dismutation and suggests the name *carboxydismutase* for the enzyme. As a consequence of this knowledge of each of the steps in the photosynthetic CO_2-reduction cycle, it is possible to define the reagent

requirements to maintain it. The net requirement for the reduction of 1 molecule of CO_2 is 4 equivalents of H and 3 molecules of ATP. These must ultimately be supplied by the photochemical reaction. Some possible ways in which this might be accomplished are discussed.

The requirement of 4 equivalents of H and 3 molecules of ATP for the reduction of each molecule of CO_2 in the photosynthetic carbon-reduction cycle suggests the possibility that respiration may contribute some of the energy required for photosynthesis by supplying some of the ATP. This possibility was studied by measuring the quantum requirement of photosynthesis at various ratios of photosynthesis rate to respiration rate. Both corrected and uncorrected quantum requirements approach an experimental value of 7.4 with increasing photosynthetic rates, whereas the corrected rate approached 4 as the photosynthetic rate approaches zero. This may indicate a contribution of respiratory energy, probably as ATP, to photosynthesis.

We thus have the possibility of an interplay between the photosynthetic apparatus in the chloroplasts and the rest of the energy-converting apparatus of the cell outside at, at least, two points—namely, a number of intermediates in the carbon-reduction cycle which are common to both, as well as generalized energy storage chemicals such as ATP, which are generated and used by both. Although we can recognize a few of the conditions that will control the relative contributions to cellular behavior of these two processes, it remains for the future to establish precisely the externally controllable variables that can influence not only both processes but their interplay as well.

This work was sponsored by the U.S. Atomic Energy Commission.

Spectroscopic Effects Coincident with the Onset of Oxidative Phosphorylation in Mitochondria

Britton Chance and G. R. Williams,
University of Pennsylvania

The respiratory chain is believed to consist of a series of 1- or 2-electron oxidation-reduction processes, of which the reaction of the ferrous and ferric forms of two cytochromes, $a''' + c'' \rightarrow a'' + c'''$, is an example. This chain catalyzes electron transport from reduced pyridine nucleotide (DPNH) to oxygen, the latter being reduced to water. A portion ($\sim$ 10,000 cal) of the free-energy change of this reaction is conserved and, through one or more transformation reactions, affords the energy necessary to convert adenosine diphosphate (ADP) to adenosine triphosphate, the latter providing a ready source of energy for cell function. This process of oxidative phosphorylation is best studied in mitochondria prepared from liver by homogenization and differential centrifugation (Schneider). An interesting property of carefully prepared mitochondrial suspensions is that their electron transport becomes severely inhibited (more than 90 percent) when added ADP is exhausted, and the transformation reactions can proceed only slowly (Lardy).

Our spectroscopic observations of the turbid mitochondrial suspension show that this inhibition reaction is accompanied by changes in the steady-state levels of six members of the respiratory sequence—the components near oxygen becoming more oxidized and those near substrate becoming more reduced. Between cytochromes *c* and *a* there is a "crossover" point in the sign of these changes as if an inhibitor reacted with a''' or c''. Evidence in favor of the idea that the reduced component is combined with the inhibitor, *I*, to form, for example, a high-energy compound, $c'' \sim I$, is afforded (i) by the fact that the inhibited respiratory chain is found to contain considerable amounts of reduced forms of cytochromes *c* and *b*, flavoprotein, and especially DPN, and (ii) by kinetic studies that show very little activity of the inhibited system in DPNH oxidation but show considerable activity in flavoprotein reduction. Thus cytochrome *c* is identified as a site of oxidative phosphorylation. Addition of various azide concentrations shifts the "crossover" point along the respiratory chain so that cytochrome *b* and DPNH can also be shown to be similarly involved in phosphorylation. More recent evidence in favor of this mechanism is afforded by the reaction of amounts of ADP with the azide-inhibited respiratory chain roughly equivalent to the measured content of DPNH. Such a reaction is understandable if the DPNH is bound as DPNH $\sim I$. This reaction would also explain the small dinitrophenol-sensitive phosphorylation observed by Lehninger in cyanide-inhibited systems.

Comparative Considerations Concerning the Dirichlet Principle and the Douglas Principle

Jesse Douglas, *Columbia University*

The title and contents of a recently published book, *Dirichlet's Principle*, as well as the general tendency of some recent mathematical writings, have seemed to promote among nonconnoisseurs the impression that one can solve the Plateau problem with this classic principle. All such attempts, however, extending over an 80-year period in mathematical history (1850–1930), met with failure. The fact is, of course, that the Plateau problem presents a new difficulty of essentially higher order than the fundamental problems in complex variable and conformal mapping whose solution, following the lead of Riemann, has been based on the Dirichlet principle.

The Plateau difficulty could be resolved only by an entirely fresh approach. I developed such a new method during the years 1926–29 and described it in a series of abstracts [*Bull. Am. Math. Soc.* (1927–30)]. A fully detailed paper appeared in [*Trans. Am. Math. Soc.*] 1931. The Douglas principle consists in the minimizing of the functional $A(g)$ = mean square of the ratio of corresponding chords of the given contour Γ and the unit circumference C (times π). The argument g is an *arbitrary, unspecified,* one-one continuous *map* of C onto Γ, and corresponding chords are those whose end-points are correlated by g.

In the main form of Dirichlet's principle, on the other hand, the argument φ in the basic functional $D(\varphi)$ is a *numerical*-valued function with a *prescribed* value $f(p)$ at each point p of the boundary Γ of a given plane region.

These comments are elaborated along the general lines of my previous paper, "Remarks on Riemann's doctoral dissertation," [*Proc. Natl. Acad. Sci. U.S.* **24**, 297 (1938)].

Concentration of Lattice Defects in Crystals Produced by Reactor Irradiation

G. J. Dienes, *Brookhaven National Laboratory*

A relatively high concentration of lattice defects can be produced in crystals by high-energy particle bombardment. Radiation effects are of great interest as new tools for probing the intricate connections between measurable crystal properties and crystalline imperfections. An outstanding problem in this field is the absolute measurement

of the number of imperfections introduced into the crystal.

Recent work (with J. J. Antal and R. J. Weiss) indicates that neutrons of sufficiently long wavelength (6 to 12-A range) are scattered isotropically by isolated point defects and that this scattering can be measured when crystalline effects (Bragg scattering) are absent (Babinet's principle). The cross section for this nuclear type of scattering is accurately known from other measurements. The attenuation of a long wavelength neutron beam during its passage through the material can be measured in transmission. Experiments are presented which indicate that the number of defects can be measured by this technique in an absolute way with good accuracy.

Another attractive method is to study the number and nature of displaced atoms by means of changes in optical properties. For this purpose one must separate the effects resulting from displaced atoms from those produced by ionizing radiation. This has been accomplished recently (with Paul W. Levy) using α-Al_2O_3. Absorption bands specific to reactor irradiation have been found. Some properties of these bands are presented. Potentially this is also an absolute and very sensitive method for determining defect concentration. Combination of these two techniques should cover a wide range of imperfection concentrations.

This work was performed under contract with the U.S. Atomic Energy Commission.

Toxicity of Serum from Irradiated Animals

Abraham Edelmann, ***Brookhaven National Laboratory***

The existence of a substance elaborated as a result of irradiation and carried by the blood has long been postulated. Much indirect evidence for its existence has been found but no direct evidence.

In the present experiments, serum taken from rats that were given 1000 r of whole-body x-irradiation 24 hr prior to collection of the blood causes death in unirradiated adrenalectomized rats. Serum from unirradiated rats does not have this effect. In similar tests 0.2, 0.4, 0.6 ml of serum from irradiated rats is toxic to adrenalectomized mice, the time being dose-dependent. The effects of the toxin are additive with those of whole-body x-irradiation, as is indicated by the fact that there is a much higher mortality in mice receiving x-irradiation plus serum from irradiated rats than for mice receiving the same dose of radiation plus control serum. Hematological effects qualitatively similar to those seen after irradiation occur after serum injection. The toxic effect disappears upon standing 30 min at 25°C and is retained overnight at 0°C. Ten hours after irradiation is the earliest time it is detectable and its concentration appears to increase after this time.

Research carried out at Brookhaven National Laboratory under the auspices of the U.S. Atomic Energy Commission.

Etiology of Gastric and Duodenal Ulcers

Lester R. Dragstedt, ***University of Chicago***

The concept is proposed that ulcers are due to a hypersecretion of gastric juice rather than to a local decrease in the resistance of the mucous membrane to digestion and, further, that the hypersecretion of gastric juice in duodenal ulcer patients is usually of nervous origin, whereas the hypersecretion of gastric juice in gastric ulcer patients is usually of hormonal origin and is caused by hyperfunction of the gastric antrum. Patients with duodenal ulcers secrete from 3 to 20 times as much gastric juice in the empty stomach at night as do normal individuals. A hypersecretion of this degree, if reproduced in experimental animals, invariably leads to the production of duodenal ulcers. This hypersecretion is abolished if the vagus nerves to the stomach are divided; and, roughly paralleling the fall in the secretion of gastric juice, the pain of ulcer disappears and the lesions heal and remain healed.

The antrum of the stomach is the sole source of the gastric secretory hormone, the gastrin of Edkins. Factors that stimulate the antrum to release gastrin have been found to be prolonged contact of the antrum mucosa with food and tension within the antrum aroused by peristalsis. In patients, antrum hyperfunction usually results from stenosis at the pylorus or stasis in the stomach as a result of impaired motility. Both factors are frequently present in patients with gastric ulcer.

Helium II in Rotational Flow

R. P. Feynman, ***California Institute of Technology***

It will be argued that in liquid He II flowing at absolute zero the circulation on any path must be quantized at an integral multiple of a unit $2\pi\hbar m^{-1}$ (m is the atomic mass of He^4). If the velocity is continuous in a simply connected region, this requires $\nabla \times V = 0$. In general the velocity will not be continuous, however; the vorticity will be zero everywhere except on certain line singularities (near which the velocity varies inversely as the distance to the line). These quantized vortex lines, suggested also by L. Onsager [*Nuovo. Cimento.* **6**, supp. 2, 249 (1949)], will appear whenever rotational flow is demanded. Thus in a rotating cylinder, rotating at angular velocity ω, $2\omega m/\hbar$ lines will form per square centimeter parallel to the axis (hence, the average vorticity is 2ω, as required). Energy is required to form these lines. The flow through a thin tube will be irrotational and frictionless as long as kinetic energy sufficient to form vortex lines is not available. The critical velocity, estimated in a rough manner from this, is of the same order as the experimental values. At much higher velocities so many lines can be formed that the quantization is not important and the resistance should approach that for turbulent fluids. It is proposed that rotons are the smallest ring vortices that such lines can form. The degradation of turbulent motion at absolute zero to heat is discussed qualitatively in this view.

Depression of Estrone-Induced Uterine Growth by Steroids

Charles Huggins and E. V. Jensen, ***University of Chicago***

The exuberant uterine growth, which is induced in hypophysectomized albino rats by the injection of estrone, can be inhibited to the extent of 30 to 40 percent by the simultaneous administration of certain other steroids. In the estrane series, such inhibitory steroids include estriol (in confirmation of the results of *Hisaw* et al.), 16-*epi*-estriol, estradiol-3,16α, estradiol-3,16β, and 6-ketoestradiol-3,17β. In the androstane series, depression of estrogen-induced uterine growth was observed with dehydro-*epi*androsterone, 4-androstene-3,17-dione, and 4-androsten-3-one but not with testosterone. In the pregnane series, effective inhibitors include progesterone (in confirmation of Courrier), 5-pregnen-3β-ol-20-one, 11β-hydroxyprogesterone, desoxycorticosterone and cortisone, whereas the 17-*iso*pregnane derivative, ethinyltestosterone was likewise effective.

On the basis of the present results, it appears that

introduction of a hydroxyl group at C_{16} or a ketone group at C_6 imparts inhibitory properties to the phenolic estrogen molecule, whereas the Δ^4-3-ketone grouping and the presence at C_{17} of a carbonyl group or a two-carbon side chain are molecular features that contribute to the inhibitory ability of compounds of the androstane and pregnane series.

Mathematical Analysis of Atmospheric Pollution in an Urban Area

François N. Frenkiel, ***Applied Physics Laboratory, Johns Hopkins University***

Mathematical models of atmospheric pollution can be used to study the probable pollution patterns in an urban area. One of the simplest models can be constructed by including in the description of the model (i) the distribution of pollution sources and their emission conditions, (ii) the micrometerological characteristics that directly affect the dispersion of pollutants, and (iii) the orographic conditions of the area. The sources of pollution may include point sources and area sources that have intermittent or continuous emissions. The description of the micrometeorological conditions depends on the scale at which the pollution is to be studied. The wind velocities are separated in "mean" wind velocities corresponding to this scale and in turbulent fluctuations. A thermal inversion is represented by proper boundary conditions. The statistical theory of turbulent diffusion can then be applied to determine the mean concentration distribution of pollutants due to each pollution source. Under simplified assumptions, one can then determine the mean concentration pattern of pollution over the urban area as a function of the time. The relative contributions of each of the pollution sources to the local contamination at various points of the area can then be determined.

As an application of this method of study of atmospheric pollution, the case of Los Angeles County has been considered. In particular, the probable mean concentrations from point sources representing certain polluting industries are compared with those representing the pollution from automobiles distributed over the county. The relative contribution of the various sources are then determined as a function of the hour of the day and compared with some experimental measurements. The use of high-speed computing methods in this analysis has been examined.

This work was supported by the Bureau of Ordnance, Department of the Navy, under contract NOrd 7386.

Central Versus Sensory Control of Food Intake in Genetically Obese Mice

John L. Fuller and George A. Jacoby, Jr., ***R. B. Jackson Memorial Laboratory***

Recessive hereditary obesity in mice was reported in 1950 by Ingalls, Dickie, and Snell. The syndrome resembles hypothalamic obesity in the rat, but this part of the brain has been described as structurally normal. Since hyperphagia in rats with hypothalamic lesions has been shown to depend upon sensory control of appetite rather than a stronger hunger drive, it was considered pertinent to learn whether this is true in obese mice.

Two treatments were employed: (i) dilution of the ordinary ration by cellulose, and (ii) adding bitter substances to the regular diet. Dilution reduced nutritive intake in obese animals more than in control nonobese sibs. Both groups ate less when the change was first made, but controls increased their intake to normal levels as their weight fell. Adjustment of intake to cope with weight loss in obese subjects was very limited. Controls adjusted to dilutions of 35 percent, and fairly well to 50 percent. Obese mice did not completely adjust to 25-percent dilution and were severely affected by 35-percent dilution. Similar differences in adjustment were found with bitter additives in the diet.

In normal well-nourished mice, food intake is under sensory control, but central mechanisms sensitive to energy needs take over when homeostasis is threatened. The central mechanisms are insensitive in obese mice. Since the effects on motivation are similar in the genetic and surgically induced syndromes, it is suggested that the genetic lesion affects hypothalamic centers.

Biochemistry as Influenced by Syntheses in the Carbohydrate Field

Hermann O. L. Fischer and C. E. Ballou, ***University of California, Berkeley***

In our laboratory, a number of phosphorylated intermediates of glycolysis and fermentation have been synthesized. This paper discusses how these chemically pure substrates were instrumental in the development of the Embden-Meyerhof scheme of glycolysis. Recently, C. E. Ballou succeeded in carrying out the synthesis of D-glyceraldehyde-3-phosphoric acid. The older synthesis of E. Baer and H. O. L. Fischer provided only the corresponding racemate. The chemical synthesis and the usefulness of this new substrate for the elucidation of metabolic pathways is discussed.

Electrification of Cloud and Rain Drops by Ionic Diffusion and Droplet Association

Ross Gunn, ***U.S. Weather Bureau***

It is found that the observed electrification of cloud droplets and rain is primarily a manifestation of the free ions produced in the atmosphere by cosmic rays and radioactivity. Such ions diffuse onto cloud droplets as a result of their thermal motions and electrify them. The electrification is systematic when the ionic conductivities of the positive and negative ions are different, but a large random electrification still persists even when the conductivities are the same. Inside of stable clouds, random electrification plays the major role and an equipartition is established between a droplet's electrostatic energy and its mean thermal energy. In such clouds diffusion processes transfer to each droplet of radius 2.5×10^{-4} cm, an average of eight elementary charges. About 47 percent of the droplets carry positive charges and another 47 percent carry negative charges. Sometimes systematic electrification of a selected sign is superimposed. A detailed estimate of the charge distribution among the droplets is found to agree with that measured on laboratory produced clouds.

When a cloud finally becomes unstable the electrified cloud droplets collide and associate to form drops that grow in size and accumulate charge. The electromechanics and statistics of the association process show that about half of the growing raindrops accumulate high positive charges, whereas the other half accumulate negative charges. An approximate equipartition is established between the electrostatic energy of the large drops and the relative kinetic energy of the smaller droplets. Esti-

mates of the magnitude and distribution of the raindrop charges are found to agree with those directly measured inside precipitating regions. Although the electrification is fully developed, even in warm clouds, the estimated charges are as large as those usually measured in thunderstorms—namely, 100 electrostatic units per gram of precipitation. The study leads directly to quantitative descriptions of a number of heretofore puzzling facts of precipitation electricity.

Studies on Protection by Treatment before and after Exposure to X- and Gamma-Radiation

Alexander Hollaender, *Oak Ridge National Laboratory*

The protection of living cells against ionizing radiation by chemical means has developed rather rapidly during the last few years. In our experiments, β-mercaptoethylamine is outstanding. Recovery in mice is favored by treatment after exposure with nonirradiated spleen (Jacobson); bone marrow (Lorenz and Congdon); and in bacteria by glutamate, guanine, and uracil. Most of the protective ability of β-mercaptoethylamine for broth-grown *Escherichia coli* is intrinsically dependent on the supply of recovery factors given afterward. The mutation rate for *E. coli* reversions is not in itself directly proportional to the amount of radiation absorbed but rather inversely to the number of organisms surviving irradiation. The mutation effect apparently is not immediate, but, rather, is a delayed effect.

In an effort to apply these findings to mammals, the mice were given S,β-aminoethylisothiouronium · Br · HBr, which appears to give better protection than β-mercaptoethylamine, is less toxic, has a wider range of protective concentration, and is considerably more stable. Bone marrow and daily injections of streptomycin were given after irradiation. Highly significant survival has been obtained in mice treated with aminoethylisothiouronium before exposure to 2400 r and injected with bone marrow suspension and streptomycin after irradiation. This is for hybrid mice, which, without protection, show a significant survival after doses of cobalt gamma-radiation somewhat higher than 800 r. It appears that the chemical treatment before exposure and treatment with bone marrow afterward are additive. It is too early to tell what the effect will be on fertility, genetic changes, leukemia, cataract induction, and so forth. These results show that it is possible to extend the survival of mammals by proper treatment in excess of the usual accepted lethal dose.

The work on bacteria was done in cooperation with G. E. Stapleton, A. J. Sbarra, D. Billen, and C. O. Doudney. The work on mice was done in cooperation with W. T. Burnett, Jr., and D. G. Doherty.

Intensities of 30,000 Spectral Lines

William F. Meggers, Charles H. Corliss, Bourdon F. Scribner, *National Bureau of Standards*

Excepting a few hundred atomic spectral lines for which physical intensities have been measured, the intensities of spectral lines are generally given by numbers that have no meaning in comparing lines in different spectral regions or in spectra of different elements. An attempt is being made to assign detectability numbers to spectral lines actually observed when 70 chemical elements are equally diluted and excited in a copper arc. From these numbers physical intensities on a uniform scale are being determined for about 30,000 lines of 70 elements excited in a d-c arc between electrodes of pressed pure copper powder to which 0.1 atomic percent of an element was added. One atom of an added element then radiates in competition with 1000 copper atoms and emits a simplified spectrum of its stronger lines.

The spectra from 2000- to 9000 A were photographed with a stigmatic concave grating spectrograph while a stepped sector was rotating in front of the slit. Apparent intensities of all added element lines observed were first determined relative to internal standards in the copper spectrum and then converted to true intensities by comparing the copper spectrum with that of an incandescent ribbon filament lamp operated at a known temperature.

That these intensity numbers really represent true relative energies was proved by comparing them with accurately measured relative intensities of lines in multiplets and with relative *gf* values of lines measured by R. B. and A. S. King [*Astrophys. J.* **82**, 377 (1935); *ibid*, **87**, 24 (1938); *ibid.* **105**, 376 (1947)] in furnace absorption spectra of several elements. The latter comparisons indicate that the temperature of a 220-v, 10-amp, copper arc is 4940 ± 290°K. This fact permits the conversion of our intensity numbers to transition probabilities or line strengths or relative *gf* values which may be of value to astrophysicists and to theoretical physicists.

Phenomenon of Sudden Death in Man and Animals

Curt P. Richter, *Johns Hopkins Medical School*

Cannon reported on sudden death in man under voodoo influence. Rats apparently die a similar death under restraint or in situations in which they are helpless.

Theory of the Auroral Zone

Donald H. Menzel, James W. Warwick, Robert S. Lawrence, *Harvard College Observatory*

Sidney Chapman suggested many years ago that clouds of highly ionized gas, ejected from disturbed regions of the sun, cause many terrestrial magnetic storms. During the initial phase of a magnetic storm, the ion cloud, moving earthward, pushes and compresses the earth's magnetic field into the space between the cloud and the earth. During this compression, the magnetic field exerts a reaction force against the surface of the cloud.

Calculating on the basis of a plane cloud, Chapman recognized that the magnetic pressure vanishes at two points, where the cloud can penetrate into the earth's field. Tracing the course of such a horn of gas, as it moves along a line of magnetic force down to the auroral zone at the surface of the earth, we find that it converges to a point some 27 deg from the geomagnetic pole.

This simple theory of the auroral zone predicts that auroras would occur on the sunlit hemisphere at just two locations—in direct contradiction to the observed occurrence of auroras at night, along the entire auroral zone. However, the simple theory neglects important effects resulting from the formation of a hollow in the surface of the ion-cloud. We show that the hollow in fact allows horns to spread in longitude completely around the auroral zone. The broad sheet of auroral matter follows a path practically identical with that of the simple theory.

Precise Measurement of Infrared Spectra

Earle K. Plyler, ***National Bureau of Standards***

During the last 2 years a method of measurement has been in operation at the National Bureau of Standards which makes it possible to determine the wavelengths of infrared atomic spectra and of the absorption lines of molecular spectra with an error of 1 part in 500,000. In the region of 5 μ spectra are measured to a precision of 0.1 A. The method consists of using the interference pattern from a Fabry-Perot interferometer as a comparison spectrum. The interference maxima are translated to wave numbers by superimposing standard atomic lines on the recorded fringe system.

Application to measurement of wave lengths of the infrared atomic spectra of Hg, Kr, and Xe is given. The fundamental band of carbon monoxide has also previously been measured by this method and the results obtained for this molecule are discussed. After other bands have been measured, there will be available a set of standard wave lengths for the infrared region.

Energy and Angular Distribution of Singly Scattered Electrons

L. Marton, J. A. Simpson, T. McCraw,
National Bureau of Standards

The energy and angular distribution of medium-energy electrons scattered by solids have been measured with an energy resolution of better than 1 part in 1500 and an angular resolution better than 10^{-2} rad. The instrument, which is automatic, uses thin foils (100 to 400 A) as targets.

To date the materials studied have been metals and particularly gold. The typical energy spectrum consists of an elastic peak and one or more characteristic inelastic peaks on a continuous background. The relative cross sections of these peaks vary strongly with angle. A typical angular distribution at fixed energy consists of a very rapid fall off of intensity, ending at about 20 min of arc followed by a long flat portion extending out to the first diffraction maximum at about 2 deg. The exact shape is a function of material, thickness, and degree of crystalline orientation.

The relationship of these scattering patterns to the current theories is briefly discussed.

Experimental Origin of a Reproductively Isolated Population in the Grass Genus *Elymus*

G. Ledyard Stebbins, ***University of California, Davis***

The grass species *Elymus glaucus* is known to consist of a large number of entities which are highly fertile within themselves, but which form sterile hybrids when crossed with each other. Some of these genetic microspecies can be defined on morphologic grounds, while others cannot. Many of them vary in the direction of other species with which *E. glaucus* frequently forms natural hybrids, particularly *Sitanion jubatum* and *S. hystrix*. This has led to the hypothesis that they originated by backcrossing from these highly sterile natural hybrids. To test this hypothesis, clonal divisions of an artificial F_1 hybrid between *E. glaucus* and *S. jubatum* were interplanted with divisions of the *E. glaucus* parent.

From 150,000 florets harvested from the hybrid, four plants of the first backcross progeny were obtained. Three of these were sterile; one had 10 percent of seed setting. Progeny of this plant from two generations of self-fertilization were highly fertile, only moderately variable, and agreed with *E. glaucus* in external morphology and chromosome number, except that they possessed a few characteristics suggesting *Sitanion*. When these plants were crossed with the *E. glaucus* parent of the original hybrid, the F_1 progeny of this cross were highly sterile. This origin of a genetic microspecies without change in the chromosome number is explained on the basis of segregation of small differences in chromosome structure which were the basis of the sterility of the F_1 *E. glaucus* × *S. jubatum* hybrid.

Cosmic Rays Outside of the Earth's Atmosphere

James A. Van Allen, ***State University of Iowa***

Cosmic radiation has been studied outside of the appreciable atmosphere of the earth over a range of geomagnetic latitudes from the equator to the North Pole. These studies have been made by means of equipment borne by high-altitude rockets. With the help of the theory of the motion of charged particles in the earth's magnetic field, there has resulted a considerably expanded and improved knowledge of the following matters: the cosmic-ray intensity in the astronomical vicinity of the earth, the momentum spectrum of the primary radiation, the cosmic-ray albedo of the atmosphere, the absence of low-momentum primaries, and the cosmic-ray energy balance in the atmosphere. Measuring techniques and detailed results are sketched and interpretation in terms of the aforementioned aspects of the subject are given.

Heat Balance of the Earth, the Moon, and Mars

Harold C. Urey, ***University of Chicago***

Recently published abundances of potassium, uranium, and thorium in meteorites are so high that much greater heat would be generated in the earth than is being lost if these abundances are characteristic of the earth. It is suggested that these elements have been concentrated in the meteorites by a factor of 3.2 or perhaps more. In this way it is possible to secure agreement in the heat balance of the earth.

If these smaller amounts of these elements represent the solar and planetary abundances, it is possible to account for the high rigidity of the moon and the characteristics of Mars. Melting such as is observed in the meteorites, if it was produced by radioactive heating by K, U, and Th, as suggested by Kuiper (at the AAAS meeting, Boston, December 1953), would require very long periods of time. It seems likely that this melting was due to short-lived nuclides produced only shortly before the formation of the sun, or to other sources of heat.

Induction of Additional Hybrid Sterility in *S. cereale* × *montanum* by Irradiation of Pollen

Samuel Price, ***U.S. Department of Agriculture***

The interspecific F_1 hybrids, *Secale cereale* L. × *montanum* Guss. exhibit great variability in pollen fertility and seed set. Meiotic irregularities and this partial sterility were studied in "control hybrids" and in "r-hybrids." The latter were obtained by x-irradiation (about 1250 r) of the pollen used in the hybridization.

Control hybrids are heterozygous for two reciprocal translocations which are responsible for a maximum association of $4_{II}+1_{VI}$. Inversion bridges occur but in no greater frequencies than within parental species.

Of 26 r-hybrids that were examined cytologically, 17 contain additional induced translocations. Inversions have been induced in several plants. One r-hybrid exhibits fragmentation in meiosis. Another contains a small centric ring fragment.

In control hybrids, pollen fertility and seed set vary independently, and neither is correlated with detectable chromosome irregularities. A large portion of the variation that obscures the effects of chromosome aberrations is thought to be genic. Genes that effect fertility within the parental species might well be the basis of this variable, interspecific, partial sterility.

In r-hybrids, pollen fertility and seed set are weakly correlated, but neither is correlated with observable chromosome irregularities. A cytologically undetectable addition to genetic variation has been induced which influences pollen fertlity and seed set similarly. Induced "point" mutations are not entirely discounted, but the addition to sterility is more likely based in cryptic structural changes in the chromosomes.

Diurnal Variation of Irregular Geomagnetic Fluctuations

Seth B. Nicholson, ***Mount Wilson and Palomar Observatories***
Oliver R. Wulf, ***U.S. Weather Bureau, California Institute of Technology***

We have studied the diurnal variation of irregular geomagnetic fluctuations in moderately low latitudes using the eight daily K numbers (3-hr-range indices) for the seven years 1940–46 and for the six observatories Alibag, Watheroo, Honolulu, Tucson, San Juan, and San Fernando. These observatories were chosen because they are fairly uniformly distributed in longitude, being at 73°E, 116°E, 202°E, 249°E, 294°E, and 354°E, respectively.

A local time variation, to be expected from the work of earlier investigators, is apparent also in these data. The present data indicate a minimum near sunrise and a maximum in the late evening. This diurnal variation appears to have a small seasonal change.

When the local time variation is deducted from the original data for each observatory, the remainders suggest a universal time variation that exhibits a pronounced seasonal change.

Remarkably Preserved Miocene Arthropods from the Mojave Desert

Allison R. Palmer, ***U.S. Geological Survey***

Insects, arachnids, and crustaceans, in a state of near perfect preservation, have been recovered from limestone nodules in lacustrine sediments of Miocene age from the Calico Mountains in the Mojave Desert, California. Specimens representing 25 species are partly or completely replaced by silica, celestite, calcite, analcite, or an undetermined organic compound. External details are exquisite in many instances, and remarkable examples of internal anatomical features are preserved in three insect species. This is the first record for most of these features in fossils.

Remnants of the tracheal systems can be observed in dytiscid beetle larvae, adult midges, and dragonfly larvae. Spermathecae were found in several female midges and internal genital structures in a male. One midge pupa contains a perfectly preserved adult female, which was ready to hatch. Part of the thoracic tracheal system and the spermathecae are visible within this female. Color patterns are present on both male and female midges. A dragonfly larva shows the rectal gill system, the heart, part of the alimentary canal, Malpighian tubules, and muscles.

Absence of Amino Acid Incorporation into Antibody during the Induction Period

W. H. Taliaferro and D. W. Talmage, ***University of Chicago***

Donor rabbits were given two injections of bovine serum albumin a month apart. Three days after the second injection, at about the end of the induction period when there was some coprecipitating but no precipitating antibody in the serum, the spleen was removed, minced, and injected into normal recipient rabbits. The recipients showed an early rise of serum-precipitating antibody owing to the transferred splenic cells. Donors or recipients were administered various amounts of yeast hydrolyzate containing amino acids labeled with S^{35}. Administration of S^{35} to seven donors resulted in only a low-grade radioactivity of precipitin in the recipient. Labeled antibody was calculated to be 0.3 to 4 percent of the antibody in the recipient and could be partly accounted for by the passive transfer of labeled coprecipitating antibody from the donor. In contrast, administration of S^{35} to three recipients resulted in a marked radioactivity of precipitin in the recipient which showed specific activities of 1.3 to 2.5 times that of the serum protein.

Control experiments indicated that S^{35} was stably bound to passively transferred antibody. The results indicate that almost all of the sulfur-containing amino acids present in the antibody are drawn from the amino acid pool during the rise of serum antibody and not during the induction period. They further suggest that the induction period is concerned with the production of antibody-synthesizing enzymes rather than of amino acid-containing antibody precursors.

Differentiation of Xylem in Plants

Ralph H. Wetmore, ***Harvard University***

In the culturing of parts of plants *in vitro*, it was found that if an apex of lilac, with two or three pairs of leaf primordia, was grafted into a piece of lilac callus, the apex grew into a plant. Moreover, in the characteristically homogeneous parenchyma of the callus host, vascular tissue developed across the graft bridge. The technique of successful grafting of apices, as Camus (1949) has pointed out, depends upon filling the incision into which the scion is placed with agar, or some similar substance, which prevents the cut cellulose walls from drying out.

Experimental evidence indicates that if the incision is filled with plain agar, response to grafting occurs on the flanks of the scion. Several to many centers of mitotic activity develop, each giving rise to a strand of differentiated xylem cells in the callus.

If instead of agar, agar containing an auxin in physiological concentrations is used in the incision, the vascular strands are found in the callus as before, but the distances from the scion are greater with higher concentra-

tions of auxin. If, instead of a grafted scion, agar containing an auxin in physiological concentration and no scion be used in the incision, vascular strands of xylem are formed in the callus as before. Thus far, no phloem has been recognized in the experiments.

The results appear to be in accord with Jacobs' findings: the production of xylem occurs when sugar and auxin are available to the callus. The corollary seems to be in the genesis of strands of xylem in the callus wherever limitations of sugar or auxin concentration are satisfied. It may well prove to be true that the vascular cylinder in a stem forms where it does because the demands for xylem formation are better satisfied in the elongate cells of the procambium than in the shorter, more or less isodiametric cells of the neighboring cortex and pith.

Fruity Mutant of the Slime Mold *D. discoideum*: Alterations in the Normal Pattern of Cellular Differentiation

Maurice Sussman, *Northwestern University*

In *Dictyostelium discoideum* wild type, cessation of growth is attended by the appearance of initiator cells within the population of myxamoebae. Each initiator evokes the formation of a multicellular aggregate by its neighbors. The aggregate is subsequently transformed into an organized fruit with spores, stalk, and basal disk cells. Under the conditions employed for analysis, the ratio of initiator cells to responder cells (the remainder of the population) is 1:2200. The genetic alteration in the fruity strain leads to an enormous increase in the number of initiators such that the ratio of initiators to responders is 1:24. The examination of aggregations by mixed populations of mutant and wild type has indicated that the mutant initiators can provide stimuli affecting any responder cell whether mutant or wild type.

The multitude of initiators in the mutant stock results in the formation of aggregates containing very few cells and correspondingly tiny fruits. Some of the latter have been found to consist of as few as 12 cells and yet to retain the normal structural relationships in terms of gross proportions and cellular morphology. The pertinence of these results to the problem of regulation in morphogenetic systems is discussed.

Differential Growth of Mental Abilities

L. L. Thurstone, *University of North Carolina*

The components of human intelligence that have been isolated during the last two decades by the methods of multiple-factor analysis are called primary mental abilities. Data have been collected for a large school population for the age span 5–19. This paper reports the mental growth curves for seven of the primary mental abilities. These are perceptual speed P, number N, the first space factor S_1, verbal comprehension V, word fluency W_1, immediate memory M_1, and reasoning R.

In order to determine the shapes of the mental growth curves, it was necessary to establish a metric. This is a scaling problem that was solved some years ago. A rational origin for the scale was determined as the point on the scale at which variability at point age vanishes since the variability cannot be negative.

All the mental growth curves so far determined are S-shaped with inflection points at an early age of 3 to 7. All of them approach maturity symptotically.

The primary mental abilities mature at different ages. The perceptual speed factor P matures to ⅘ of the adult level at about age 10. The two verbal factors mature to the same level at about age 14.

It seems likely that in the future teaching methods will be adjusted to the imagery type of each child. A child's mental profile can be determined at age 5.

News and Notes

Scientific Abstracting in the U.S.S.R.

The following article, written by D. Panov, director of the Institute of Scientific Information of the Academy of Sciences of the U.S.S.R., appeared in a recent issue of Pravda. *In translation its title appears to be "Study achievements of science and technics more profoundly."*

Well-organized information, on the achievements of science within our country and outside it, is called upon to play an important role in the struggle for the further advance of science.

About 2 years ago there was set up in the Academy of Sciences of the U.S.S.R. an Institute of Scientific Information, which pursues the aim of keeping Soviet scientists and industrial and agricultural workers permanently acquainted with the achievements of science and technics throughout the world.

In order to give Soviet readers the chance of acquainting themselves with the colossal amount of new material that is continually appearing in thousands of journals published in all the languages of the world (in the sphere of chemistry alone there are published yearly about 70,000 new articles, books, and patents), great preparational work is necessary.

The Institute of Scientific Information of the Academy of Sciences of the U.S.S.R. publishes regularly so-called "journals of abstracts" on mathematics, mechanics, astronomy and geodesy, physics, chemistry, and biology, which are, as it were, a key to world literature in the respective branches of science.

A tremendous number of journals, scientific works, books, and other literature are examined regularly in order to obtain the necessary material. In 1954, 6892 foreign and 998 Soviet periodicals were subjected to this examination.

The journals of abstracts enable readers to acquaint themselves in Russian with material published in scientific and technical journals that come out even in the most distant parts of the globe and in the most difficult languages. The summaries, besides a bibliographical description, contain a complete outline of

the articles with all their basic factual data. Moreover, it is possible to order at the Institute photo-copies of those articles of which summaries have been published. This provides scientific workers in all regions of the country with the opportunity of having the material they require from scientific literature at their disposal.

Naturally, great attention is given to the works of the scientists of the Soviet Union, the Chinese People's Republic, and scientists of all the countries of people's democracy. Their works are reflected more completely here than in the journals of abstracts published abroad.

The Soviet journals of abstracts that have been published so far are devoted to the exact and natural sciences. Journals of abstracts on technics have not yet begun to appear. Preparation is going on at present for the publication of the journals *Machine-Building* and *Electrotechnics*, including automatic machinery. They will begin to appear in the second half of this year.

Technical workers, however, will find much that they require in the journals that are already coming out. The journals of abstracts on science strive to provide material of an applied nature, of interest to designers, works laboratory assistants, and senior technical personnel at factories and works.

In the journal *Mathematics*, devoted, it would seem, to one of the most abstract sciences, there is a special section on the use of theoretical-probability methods, in particular on the theory of statistical control, which is of great importance in mass production. In this same journal there are detailed reports of the works of one of the most rapidly developing branches of science at the present time—the field of calculating machinery and its use. In the issues of *Mathematics* that have appeared, information has been published on more than 40 new types of electronic calculating machines, designed and built recently in the United States of America, Britain, France, and other countries. The majority of these modern machines calculate at high speeds. They carry out from 10,000 to 20,000 additions a second.

In this same section there is information on the new small-scale electronic calculating machine that can be installed in aircraft and used, for example, for navigation. This machine operates with data coming in from other instruments. It measures the indices of the instruments 10 times a second and produces the results of the calculation at the same rate.

In other summaries light is thrown on questions of using electronic calculating devices in controlling machinery automatically according to a complex program worked out in advance, and questions of new technology are examined, in particular that of the mass manufacture of electronic apparatus.

In the journal *Physics* there are discussions of the practical application of physics, geophysics, and meteorology. Many summaries are published on the use in technics of methods of marked atoms and supersonic sound, including supersonic sound in cleaning fur from the inside of boilers, supersonic welding of aluminum and iron, and so on. This journal published data on, for example, such new instruments as the portable "Geophone" transmitter for underground communication in mines.

In the journal *Mechanics* questions of prime importance for engineering are regularly dealt with. Readers will find there summaries on the latest designs of gas turbine engines, new types of testing machinery, the mechanical properties of a great variety of materials from heat-resistant alloys to textile fibers.

The journal *Chemistry* gives summaries in all the branches of this science In it the problems of chemical technology and other problems of importance to the chemical industry are dealt with. One can read in this journal of the new method of obtaining highly durable pig iron by blowing it with argon, of an automatic plant for turning out steel wheels for trucks by casting them under pressure in graphite molds, and of a new process for making cellulose that enables the productivity of the plants to be increased 1½ times.

The journals *Biology* and *Biochemistry* publish material that is of value, not only to the biologists, but also to medical and agricultural workers.

The publication of journals of abstracts is something new, and for this reason their work suffers from a number of shortcomings. Thus, insufficient light is thrown on patent literature, and the summaries are sometimes published after considerable delay.

This year there will come out subject, formula, and other indexes to the journals of abstracts which will make reference to the necessary material much easier. The journal containing the indexes will serve as a permanent reference book for the given science over the appropriate period of time.

The publication of Soviet journals of abstracts is a great event in the scientific life of our country. It is necessary that their readers—members of scientific institutions and academic establishments, workers of industry and agriculture—should take into account in their scientific and practical activity the relevant achievements of modern homeland and world science and technics. It is important that the journals of abstracts should find their way into every library, into every scientific institute and higher educational establishment and should reach every scientific worker, engineer, and student.

Science News

Under a recent reorganization announced by Dean Rusk, president of the **Rockefeller Foundation**, the total activities of the foundation in all fields of science have been brought into closer interrelationship. Warren Weaver, for more than 20 years the director for natural sciences, has been made vice president for the natural and medical sciences; in that position it will be his responsibility to develop, coordinate, and supervise all of the foundation's activities in science. Associated with Weaver will be three directors: J. F. Harrar, director for agriculture; Robert S. Morison, director for biological and medical research; and

John C. Bugher, director for medical education and public health. Harrar and Morison have for some time been active members of the foundation staff. Bugher originally joined the staff in 1937, and has for the past 4 years been on leave of absence to serve as director of the division of biology and medicine of the U.S. Atomic Energy Commission.

The terminology of the new positions reflects the fact that for many years the primary emphasis in the Rockefeller Foundation's program in the natural sciences has been upon modern experimental biology. But this by no means indicates a lack of interest in the mathematical and physical sciences. On the contrary, a special feature of the biological program has been a concern to aid in the application of mathematics, physics, and chemistry to basic biological problems; and occasional grants, strictly in the physical sciences, have also been made from time to time. This continuing interest in the physical sciences will be a special concern of Weaver, whose own training was in mathematics and physics.

Alan Gregg continues as vice president on special assignments; and Lindsley F. Kimball, a vice president since 1949, becomes executive vice president. Norman S. Buchanan returns to the foundation in July as director for social sciences, succeeding Joseph H. Willits, who retired in 1954. Buchanan was associate director for social sciences from 1947 to 1950. He is at present professor of economics at the University of California. Charles B. Fahs remains as director in charge of the humanities program, in which capacity he has served since 1950.

Rusk also announced the retirement of Andrew J. Warren and paid high tribute to his 34 years with the foundation that culminated in his service as director of the former division of medicine and public health. "Dr. Warren has performed distinguished service in almost every continent and made a notable contribution to the fight against yellow fever and in the development of improved public health in many countries. He will be sorely missed by his colleagues in the Foundation."

France is now constructing a **nuclear center at a Rhône River town** called Marcoule, and according to a 5-year plan announced recently by Francis Perrin, high commissioner for atomic energy, the country will have its first atomic factory at the end of 1957.

The most extensive **cloud-seeding experiment** ever attempted was conducted along the eastern coast of the United States for 9 mo during 1953 and 1954, according to Jerome Spar, New York University meteorologist who directed the study. The experiment, called "Project Scud," was organized, designed, and analyzed by the research division of the N.Y.U. College of Engineering under sponsorship of the Office of Naval Research. Information on the project was classified until recently.

From Jan. 1953 to Apr. 1953, and from Dec. 1953 to Apr. 1954, aircraft dropped 30 tons of dry ice between Florida and Massachusetts. In addition, 250 lb of silver iodide in solution were sprayed aloft from 17 generating stations from Florida to New York. The purpose of the project was to test the theory that artificial cloud seeding could modify developing storms by increasing or decreasing their intensity or by changing their direction. The answer, according to Spar, is that there is "No evidence of any large-scale meteorological effects due to seeding . . . the most careful statistical evaluation lent no support to the theory that seeding can make, break, or change a storm in a big way."

Over the 2-year period, the N.Y.U. meteorology group—which at one time numbered 25—selected 37 meteorological situations. In 18 cases, seeding was done; in 19 cases there was no seeding. The 19 nonseeding cases were control situations. Seeding and nonseeding situations were paired, and until the missions were completed the investigators did not know which situation in a given pair was the seeded one. The selections of situations for seeding were made by chance at the ONR project office in Norfolk, Va.

During the two seeding seasons, N.Y.U. meteorologists manned a weather station on the campus on a 24-hr basis. When an appropriate meteorological situation was forecast, they telephoned Norfolk at least 10 hr in advance of a suitable "zero hour," the time when planes would begin dropping their dry-ice load and the 17 ground generators would be ignited simultaneously.

In the first winter's seeding flights, three planes flew parallel 1000-mi tracks, 100 mi apart. In nonseeding cases, only one plane flew, not dropping dry ice but making meteorological observations for comparison with data obtained during the seeded situation. During the second season, planes flew in up-and-down target areas approximately 500 mi long.

The pairing system and the conduct of the experiment over two winters insured that results would not be affected by freak weather. The winter of 1952–53 proved to be one of the wettest on record, but there was no evidence of a connection between that fact and the seeding project. The negative finding of Project Scud, Spar pointed out, does not discount local effects of cloud-seeding; the experiment was designed only to examine possible large-scale effects.

The Department of Defense on 1 Apr. announced an important **change in the loyalty oath** required of college students enrolled in the basic course of the Reserve Officers Training Program. An oath—in such form as prescribed by the Secretary of Defense—was required by a rider to the Defense Department Appropriation Bill passed in 1954. The new oath is:

> I do solemnly swear (or affirm) that I will support and defend the Constitution of the United States against all enemies, foreign or domestic; that I will bear true faith and allegiance to the same; and that I take this obligation freely, without any mental reservation or purpose of evasion; so help me God.

This oath replaces a much longer and more detailed one in which the student was required to make a

declaration concerning his standards of conduct and his membership in, association with, or attendance at meetings of organizations on the "Attorney General's List."

Waldo L. Schmitt, head curator of zoology, U.S. National Museum, is directing an expedition sponsored by the Smithsonian Institution that is to spend between 2 and 3 mo investigating the invertebrate fauna of **the Belgian Congo,** with special emphasis on the mites and ticks, as well as their plant and animal hosts. The crustacean fisheries operated by the natives in the extensive Congo River sytsem and tributaries will also be studied.

The party includes Edward Baker of the Entomology Research Branch of the U.S. Department of Agriculture, who is particularly interested in the mites of importance or potential importance to agriculture in the United States, and Roy Lyman Sexton of Washington, D.C., a medical consultant who has previously conducted surveys for the Government on the health of native populations. His son, Roy L. Sexton, Jr., chief of the photolaboratory at Walter Reed Medical Center, has been lent to the expedition as microphotographic specialist. The group entered the Congo at Leopoldville on 10 Apr. and is proceeding by automobile across country from west to east in order to go down the Nile to Cairo before returning to Washington.

The U.S. Navy announced on 10 Apr. that an experimental **one-man wingless platform** has made short successful flights. A circular machine approximately the width of a man, it is held in the air by a set of counter-rotating propellers on the underside that suck air through holes in the platform. Designed and built by Hiller Helicopters, Palo Alto, Calif., it has not flown more than a few feet from the ground. It is stabilized and controlled by the same instinctive reactions a person uses to stand upright—the pilot just leans in the direction he wants to go.

The craft is covered at the side with a circular casing to provide protection from the propeller blades, and it is supported by four spherical legs. The pilot stands inside a ring of metal about as high as his waist. Two separate engines, which together develop less than 100 hp, turn the propellers.

On 13 Apr., Sen. Frederick G. Payne (R, Me.) introduced in the Congress a resolution (S. Con. Res. 22) concerning the **effects of radiation.** The final paragraph reads:

> *Be it resolved by the Senate (the House of Representatives concurring)*, That the Congress requests the President to instruct our chief delegate to the United Nations to take whatever steps may be necessary to propose and urge the formation of an international scientific commission within the United Nations to study and determine the effects on living organisms of radioactivity released by nuclear explosions.

A statement by the Federation of American Scientists endorsing the resolution points out that the plan to appraise radiation effects announced on 8 Apr. by the National Academy of Sciences [*Science* **121**, 543 (15 Apr. 1955)] would provide a reliable technical evaluation of the problem. The FAS believes, however, that worldwide acceptance of such an evaluation is most likely to be accorded the findings of a U.N. commission such as that proposed by Sen. Payne.

A survey of the January graduating class at Illinois Institute of Technology shows that these **engineers received an average starting salary of $383** per month, an all-time high and $10 more than a year ago. Some 200 companies sent representatives to interview the graduates, and each was interviewed by an average of seven companies.

Chemical engineers received an average starting salary of $398, a $4 increase over January 1954, and in mechanical engineering salaries jumped from $370 to $392 per month. Starting pay for electrical engineers went from $367 to $386, and for industrial engineers from $350 to $353. The only decline was in civil engineering, where there was a drop from $388 in January 1954 to $378 this year.

Scientists in the News

The Quartermaster Research and Development Center of Natick, Mass., has announced two appointments. **Harold J. Hoge,** who was formerly associated with the research department of Leeds and Northrup Co., Philadelphia, Pa., has been made chief of the physics branch of the Pioneering Research Division; and **Dwight Williams,** former section research director for the Westvaco Chlor-Alkali Division of the Food Machinery and Chemical Corp., South Charles, W. Va., has been named chief of the biology and chemistry branch of the Chemicals and Plastics Division.

The following awards were presented during the recent meeting of the International Association for Dental Research in Chicago. The Souder award, conferred this year for the first time, was given to **Richard L. Coleman,** director of research for the J. M. Ney Co. of Hartford, Conn., in recognition of his contributions in the field of research and development of dental materials. The award was established in honor of **Wilmer Souder** in recognition of his pioneering efforts and outstanding accomplishments in dental materials research. Souder retired in 1954 as consultant for the National Bureau of Standards after more than 30 yr of service. He developed the Bureau's dental research laboratory and he has contributed extensively to the fields of dental materials, applied physics, and criminology.

The association's Novice award was presented jointly this year to **D. E. Waite** and **C. E. Staley** of the University of Iowa for their paper entitled "Pulpal changes resulting from freezing storage technics." This $100 prize is given for the outstanding research report among those submitted by individuals who have never before presented a paper at a meet-

ing of a national scientific group or published a scientific paper in a journal that has national circulation.

Alvin Radkowsky, senior physicist for the Naval Reactors Branch of the U.S. Atomic Energy Commission, has received the Distinguished Civilian Service award for his development of a method of substantially increasing the life of nuclear reactor cores, a method that also increases safety and simplifies mechanical control problems.

For research on the photographic process, **Julian H. Webb,** associate head of the physics division at Kodak Research Laboratories, Rochester, N.Y., has been awarded the 1954 Progress medal of the Royal Photographic Society of Great Britain. He was cited for his "important series of studies of the photographic process extending over many years." These studies deal with the fundamental theory of photographic exposure and the structure of the latent image. Webb was the first to apply quantum mechanical principles to the action of light on crystals of light-sensitive silver salts. In addition, his investigations have covered the effects of light exposure on photographic materials at varying light intensities and different temperatures. He is also credited with research on the relationship between the sensitivity properties of single grains and the characteristic curve of photographic materials.

T. G. Blocker, Jr., professor of plastic and maxillofacial surgery at the University of Texas Medical Branch, Galveston, has resigned his position as dean of the medical faculty. Blocker is expanding the research program in plastic surgery at the John Sealy Hospital.

Daniel M. Green, formerly associate clinical professor at the University of Southern California School of Medicine and director of the hypertension clinic for the Los Angeles County General Hospital, has been appointed director of research for the Nepera Chemical Co., Yonkers, N.Y. Two senior biologists, both from the University of Montreal, have also joined the firm's technical staff: **Réné Girerd** of Dijon, France, who has been serving as a research assistant under Hans Selye, and **Ernesto Salgado** of Madrid, Spain, a research associate who has published clinical papers on hypertension and other subjects.

Heinz Hopf, head of the mathematics department at the Swiss Federal Institute of Technology in Zurich, and president of the International Mathematical Union, was the recipient of an unusual honor on the occasion of his 60th birthday last December. Each of the 13 papers in volumes 28 and 29 of *Commentarii Mathematici Helvetici* was dedicated to him with the personal greetings of the author. His birthday was also celebrated at a reception which was attended by some 60 friends. Hopf was visiting professor of mathematics at Princeton in the fall term, 1950–51.

Eric K. Rideal, Kings College, London, was chairman of the symposium on "Molecular structures and interactions at surfaces" that was held at the Polytechnic Institute of Brooklyn on 23 Apr.

Albert F. Siepert, executive officer of the National Institutes of Health, Bethesda, Md., recently received the Distinguished Service Medal for outstanding accomplishments in research administration. The presentation was made by Oveta Culp Hobby, Secretary of the U.S. Department of Health, Education, and Welfare, at a ceremony that also honored three other NIH employees with Superior Service awards: **W. F. von Oettingen,** National Institute of Arthritis and Metabolic Diseases, for outstanding contributions to the fields of toxicology, industrial hygiene, and public health; **Frank J. McClure,** National Institute of Dental Research, for contributions to nutrition and public health dentistry; and **Bruce P. Phillips,** National Microbiological Institute, for work with the parasite *Endamoeba histolytica* through the use of germ-free animals.

Werner Braun, medical bacteriologist and chief of the variation branch of the Chemical Corps Bacteriological Laboratories at Camp Detrick, Md., has been appointed professor of microbiology and member of the Rutgers Institute of Microbiology.

Victor H. Cahalane, chief of the Wild Life Division of the U.S. National Park Service, has been named assistant director of the New York State Museum at Albany, effective 1 May. He succeeds **Alvin G. Whitney,** who has retired.

Hendrik de Wet Erasmus of the Electro Metallurgical Co., Niagara Falls, N.Y., whose research in chemical engineering has helped to clarify the chemistry of carbon and silicon, has won the 1955 Jacob F. Schoellkopf medal of the American Chemical Society's Western New York Section. The medal will be presented at a meeting of the section in Niagara Falls on 17 May.

Erasmus, head of the company's metals research laboratories, was cited for his contributions to metallurgy and industrial chemistry, particularly his development of a technique for using extremely high vacuum in the separation of carbon and sulfur from other elements. Iron alloys of unusually low carbon content are possible as a result of this work.

Donald E. Gregg of the Army Medical Service Graduate School's department of cardiorespiratory diseases, Walter Reed Army Medical Center, Washington, D.C., presented the main lecture for the Deutsche Gesellschaft für Kreislaufforschung at Bad Nauheim, Germany, on 15 Apr. He is also lecturing and giving seminars in Belgium, Sweden, and Switzerland.

Theos J. Thompson, who has been in charge of the design and construction of the Omega West Reactor that is being built at the Los Alamos Scientific Laboratory in New Mexico, has been appointed associate professor of nuclear engineering in the department of chemical engineering at Massachusetts Institute of

Technology. He will play a leading role in M.I.T.'s work in nuclear technology, and his immediate assignment will be as director of the institute's project for construction of New England's first privately-owned nuclear reactor.

Necrology

Ubaldo L. Bizzarri, 52, associate professor of pediatrics at the New York Medical College, New York, 4 Apr.; **Harry E. Crum,** 62, assistant chief geologist of the Columbian Carbon Co., New York, 1 Apr.; **Stanford C. Hooper,** 70, investigator in radio electronics, former director of Naval Communications, former chairman of the Naval Research Commission, Miami, Fla., 6 Apr.; **John B. Klumpp,** consulting gas engineer, Philadelphia, Pa., 29 Mar.; **Henry Landesman,** 65, electrical engineer, author, Morris Plains, N.J., 5 Apr.; **Leo B. Norris,** 62, former associate professor of Physiology and professor of physical diagnosis at Georgetown University Medical School, Washington, D.C., 29 Mar.; **William H. Ordway,** 66, tuberculosis specialist, Longmeadow, Mass., 1 Apr.

George H. Parker, 90, experimental zoologist, author, emeritus professor of zoology at Harvard University, retired director of the Harvard Zoological Laboratories, Cambridge, Mass., 26 Mar.; **Kaufman Schlivek,** 74, former clinical professor of ophthalmology at the College of Physicians and Surgeons, Columbia University, New York, 31 Mar.; **Edgar A. Singer, Jr.,** 81, psychologist, author, emeritus professor of philosophy at the University of Pennsylvania, Philadelphia, 3 Apr.; **Donald Y. Solandt,** 48, head of the University of Toronto's department of physiological hygiene, Toronto, Canada, 30 Mar.; **Israel Strauss,** 81, neuropsychiatrist, author, former instructor in histology at Cornell Medical School, New York, 4 Apr.; **John Treacy,** 30, assistant professor of chemical engineering at the University of Notre Dame, South Bend, Ind., 31 Mar.; **Francis J. Williams,** 47, former assistant professor of ceramics at Pennsylvania State University, director of Research and Development Laboratories, Baroid Division, National Lead Co., Houston, Tex., 19 Mar.

Meetings

The 5th **Weather Radar Conference** and 139th national meeting of the **American Meteorological Society** will be held under the auspices of the U.S. Army Signal Corps, Signal Corps Engineering Laboratories, Fort Monmouth, N.J., at the Berkeley Carteret Hotel, Asbury Park, N.J., 13–15 Sept. The program will be sponsored jointly by the Signal Corps Engineering Laboratories and the American Meteorological Society. Sessions are being planned on (i) recent developments in electronic meteorological instrumentation; (ii) techniques for the use of radar and sferics data in synoptic analysis and forecasting, including hurricane applications; (iii) techniques for the use of radar and sferics data in short range forecasting including severe weather forecasting; (iv) precipitation physics and storm structure; (v) atmospheric inhomogeneities, meteorological observations and information theoretical aspects of meteorology; and (vi) reports on operational experiences with weather radar and sferics equipments.

Titles and abstracts not exceeding 100 words in length *should be sent by 1 May* to the Director, Evans Signal Laboratory, Belmar, N.J., Attn: Local Conference Committee. Abstracts should be accompanied by an estimate of presentation time and a list of required visual aids.

A **North Central Conference on Biology Teaching,** sponsored by the National Association of Biology Teachers on a grant from the National Science Foundation, will be held at the University of Michigan Biological Station at Douglas Lake, Cheboygan, Mich., 19–30 Aug. Ninety delegates will be selected from high schools, colleges, and state departments of education in Michigan, Ohio, West Virginia, Indiana, Illinois, Wisconsin, Minnesota, Iowa, Missouri, and Kansas.

The staff selected for the conference includes Richard L. Weaver as director, John Breukelman as chairman of the steering committee, Richard R. Armacost, Paul Klinge, and Alfred H. Stockard.

The newly constructed Medical Science Building of **New York University–Bellevue Medical Center** will be formally dedicated on 2 June. Winthrop Rockefeller, honorary trustee of the Medical Center, will preside over the ceremonies, during which honorary degrees of doctor of science will be presented to Adlai Stevenson, principal speaker of the occasion, and 12 outstanding scientists representing the United States, Canada, South America, and Europe.

The objective of Columbia University's 6th annual **Conference on Industrial Research** is to explore the human relations aspect of industrial research. This theme was chosen in response to the suggestions of participants in last year's conference and as the result of replies to inquiries submitted to many researchers as to what they felt was the most pressing problem of the day. It was also chosen because the 2nd research conference was largely on the same subject, and it was felt that a periodic review, particularly the changes that occur in a 5-year period, is important. This conference will consider the research personality, the development and training of the research worker, and the rewards peculiar to his work. The objective will be to establish the place of research in industrial enterprise. While human relations are the primary consideration, several sessions will be devoted to certain unique techniques of problem-solving.

The conference will be held at Arden House on the university's Harriman campus. Ample time will be provided for clinic and panel sessions, and the emphasis will be placed on the resolution of specific problems brought to the conference by the participants. Registration is by advance reservation only.

The fee is $300, which includes meals, lodging, reference material, and the full use of recreation facilities at Arden House. *The closing date for enrollment is 1 May.* Cancellations will be accepted up to 1 June. Inquiries may be addressed to Prof. Robert T. Livingston, Director, Industrial Research Conference, 409 Engineering, Columbia University, New York 27.

The 79th annual meeting of the **American Association on Mental Deficiency** will be held 24–28 May at the Hotel Statler in Detroit, Mich. Interested neurologists, psychiatrists, pediatricians, psychologists, social workers, educators, and parents are cordially invited to attend. Further information may be obtained from Paul Voelker, Director of Special Education, Detroit Public Schools, 453 Stimson, Detroit.

The 20th **International Physiological Congress** organized by the Belgian Society of Physiology under the auspices of the International Union of Physiological Sciences, will take place from 30 July to 4 Aug. 1956 in Brussels, Belgium. An International Meeting of Pharmacology will be held during the congress. For information write the secretary of the organizing committee, Prof. J. J. Reuse, Faculté de Médecine, 115 Boulevard de Waterloo, Brussels, Belgium.

The 1955 **conference on religion in the age of science** will take place 30 July–6 Aug. on Star Island, Isles of Shoals, off Portsmouth, N.H. More than half of last year's speakers will participate [*Science* **119**, 683 (14 May 1954); **120**, 522 (1 Oct. 1954)], together with a number of new scientific and theological contributors, who will attempt to synthesize new structures of belief about man and his relationship to the source of his being.

Among the new leaders are Alfred E. Emerson, zoologist of the University of Chicago, who has developed highly significant concepts about man's ideas of right and wrong in the light of evolution; Henry Alexander Murray, Harvard psychologist, who relates scientific concepts for the handling of the conscious and unconscious tensions between man and his environmental press to religion; and Henry Nelson Wieman, emeritus professor of the philosophy of religion of the University of Chicago, who has pioneered in the merging of scientific concepts with a concept of the source of human good in a reformed statement of theology.

It may again be necessary to turn away registrants because of limited capacity. Persons seriously interested in participating are urged therefore to register as early as possible. For information, write to the conference registrar, Mrs. Rosalind Holt, Box 156, Pennington, N.J. After June 23 address her at Hotel Oceanic, Isles of Shoals, Portsmouth, N.H.

The 31st annual meeting of the **Pennsylvania Academy of Science** took place in Philadelphia, 8–9 Apr. Sessions of the Senior Academy were held at the Academy of Natural Sciences and those of the Junior Academy at the neighboring Franklin Institute. Attending were approximately 300 scientists and students from all parts of Pennsylvania and neighboring states; they heard more than 50 papers in all branches of science.

Two $150 Darbaker prizes for papers on a biological subject were awarded in the Senior Academy: Elmer C. Herber of Dickinson College was honored for his work on the "Life history studies on *Notocotylus urbanensis*, an intestinal parasite of the muskrat"; and Ralph Wichterman of Temple University was recognized for his paper on "The usefulness of the one-celled animal paramecium in studying the effects of high-dosage x-radiation." Some 20 papers were presented during the sessions of the Junior Academy, composed of high-school students from all parts of the state, and four prizes and four honorable mentions were awarded.

The **Pacific Division of the AAAS** will hold its 36th annual meeting 20–25 June at California Institute of Technology. This meeting is expected to be one of the largest ever held in Pasadena, and representatives of 25 societies affiliated with the AAAS will conduct programs in chemistry, physics, geology, biology, astronomy, psychology, botany, physiology, and zoology. Among the special events scheduled are an address on "The support of ideas" by Dean Rusk, president of the Rockefeller Foundation, and a lecture sponsored by Sigma Xi that will be delivered by Linus Pauling, Nobel laureate and chairman of C.I.T.'s division of chemistry and chemical engineering.

The registration fee of $1 entitles a visitor to receive a final program and to attend all scientific sessions and exhibits. Because there are already indications that it may be necessary to arrange for additional hotel accommodations, interested persons are urged to communicate promptly with the chairman of the general committee, Arthur W. Galston, Division of Biology, California Institute of Technology, Pasadena.

The **American Nuclear Society**, an organization composed of some 400 scientists and engineers engaged full-time in industrial, governmental, and educational aspects of atomic energy activity, has announced plans for its first annual meeting, which will be held 27–29 June at Pennsylvania State University. The meeting will be representative of all major interests in peacetime atomic energy, according to program chairman J. A. Lane of Oak Ridge National Laboratory.

Included will be papers on fast reactor technology, experimental nuclear techniques, radiation effects on biological and physical systems, sources and economics of reactor materials, and nuclear chemical problems. The conference has been specifically designed to appeal to engineers, physicists, chemists, life scientists, and metallurgists. Papers presented will deal with data not previously published in the nonsecret literature of the atomic energy field. Five symposiums have been organized, and at the banquet on 28 June the first elected officers will be installed.

The meeting, which is similar in concept to the International Conference on the Peaceful Uses of Atomic Energy that is to take place in Geneva next August, will be open to nonmembers of the society. Information may be obtained from Prof. W. W. Miller, Pennsylvania State University, University Park, Pa.

The 2nd **International Conference on Biochemical Problems of Lipids** will take place at the University of Ghent, Belgium, 27–30 July, immediately preceding the 3rd International Congress of Biochemistry at Brussels. Provisionally the program is divided as follows: physical and chemical properties; structure; methods of separation; metabolism and biosynthesis; enzyme systems; phospholipids and transport; and miscellaneous biochemical problems. Information and application forms may be obtained from the secretary of the organizing committee, Dr. P. De Moerloose, St. Jansvest 12, Ghent, Belgium.

The 6th annual **Engineering Conference** was held at Virginia Polytechnic Institute, 21–23 Apr., on the theme of "World progress through engineering." H. A. Meyerhoff, executive director, Scientific Manpower Commission, Washington, D.C., delivered the convocation talk. This conference is sponsored by the Association for the Advancement of Engineering, a student organization, in cooperation with V.P.I.'s School of Engineering and Architecture.

Thirty technical and professional men from various industries participated in the symposiums, and an equal number of industrial exhibits was displayed. The G.E. House of Magic, which was of special interest to participants in the high-school science fair, was scheduled for 2 days of the conference. More than 600 persons in industry received invitations to attend the meeting.

Society Elections

Society of American Foresters: pres., E. L. Demmon, Southeastern Forest Experiment Station, Asheville, N.C.; v. pres., DeWitt Nelson, Department of Natural Resources, Sacramento, Calif.; exec. sec., Henry Clepper, Mills Bldg., 17th St., at Pennsylvania Ave. NW, Washington 6, D.C. Representatives to the AAAS Council are Robert P. Holdsworth and Stephen N. Wyckoff.

American Psychoanalytic Association: pres., Maxwell Gitelson, Chicago; pres. elect, William G. Barrett, San Mateo, Calif.; sec., Douglas D. Bond, University Hospitals, Cleveland 6, Ohio; treas., Robert T. Morse, Washington, D.C.

National Academy of Economics and Political Science: honorary chairman, John Donaldson, George Washington University (ret.); chairman and AAAS representative, Benjamin H. Williams, Industrial College of the Armed Forces, Washington, D.C.; 1st v. chairman, Amos E. Taylor, Pan American Union, Washington; 2nd v. chairman, Ernest S. Griffith, Library of Congress, Washington; exec. sec., Donald P. Ray, George Washington University, Washington; treas., Bruce Baird, National Savings and Trust Co., Washington; asst. treas., Herbert B. Lord, National Savings and Trust Co.; general counsel, Walter H. E. Jaeger, Georgetown University, Washington.

American Fern Society, Inc.: pres., Ralph C. Benedict, Brooklyn, N.Y.; v. pres., Dwight M. Moore, Fayetteville, Ark.; sec., Mildred E. Faust, 501 University Place, Syracuse 10, N.Y.; treas., Ronald L. McGregor, Lawrence, Kans.

Phi Sigma Society: pres., Karl F. Lagler, University of Michigan; v. pres., Samuel L. Meyer, Florida State University, Tallahassee; exec. sec.-treas., Fred S. Orcutt, Virginia Polytechnic Institute; editor, A. M. Keefe, St. Norbert College, West De Pere, Wis.

Grants, Fellowships, and Awards

Grants-in-aid of research amounting to $15,874 were awarded by the **American Academy of Arts and Sciences** at its March meeting. Sixteen grants totalling $12,624 were made on recommendation of the Committee on the Permanent Science Fund. Fields covered included acoustics, biochemistry, botany, ecology, entomology, paleontology, parasitology, and sociology. One of these awards was from the Academy Research Grants in New England of the AAAS. Three grants totaling $3250 were made from the Rumford Fund to support investigations in heat and light.

Twenty-seven American biochemists have received grants to assist their travel to the 3rd **International Congress of Biochemistry** to be held in Brussels, Belgium, 1–6 Aug. Eighteen of the awards were made by the National Science Foundation, seven by the American Society of Biological Chemists, and two by the Division of Biological Chemistry of the American Chemical Society. These last were given as memorials to the late Dr. Erwin Brand.

The three organizations awarded their grants as a collaborative enterprise. All the arrangements for receipt of applications and selection of grantees were conducted jointly. All the awards were made to persons selected from a group of 188 applicants on the basis of recommendations from a committee of American biochemists appointed by the two biochemical societies.

Four **RCA predoctoral fellowships in electronics** have been awarded for 1955–56 by the National Academy of Sciences–National Research Council. These fellowships, supported by the Radio Corporation of America, are designed to give special graduate training and experience to young men and women of promise in the general field of electronics.

Candidates must have demonstrated ability and aptitude for advanced work and must have had training in electronics equivalent to that represented by 1 year of study beyond the bachelor's degree in a university of recognized merit. These fellowships, which are re-

stricted to citizens of the United States, are awarded only for study and research in this country.

Research grants totaling $14,000 to three institutions have been announced by the **Upjohn Co.**, Kalamazoo, Mich. The three awards were for work on the nucleic acid metabolism of virus infected cells, endocrinology research, and for studies on the synthesis of condensed ring systems.

In the Laboratories

Managers have been appointed for two newly formed research sections at the **General Electric Research Laboratory**, Schenectady, N.Y. P. E. Pashler is manager of the applied physics section, and Richard L. Shuey is manager of the information systems section; both sections are under the Electron Physics Research Department.

The Atomic Energy Commission has announced approval of a study of reactor technology by the **General Dynamics Corp.** The company will investigate nuclear power equipment such as small power reactors and specially designed components of reactor systems with a view to manufacturing such products. It will also explore various problems related to the peaceful uses of nuclear energy; for instance, decontamination services, utilization of by-product radiation, instrumentation, waste disposal, and so forth. The company estimates it will spend $200,000 on the study, which will take 1 year.

General Dynamics manufactures submarines, aircraft, motors, electronic apparatus, and industrial processing equipment. It has had wide experience in uses of atomic energy for military purposes, including construction of the submarine "Nautilus."

Macalaster Bicknell Co., Inc., has announced its first major **Scientific Instrument Symposium** to be held in its plant at 243 Broadway, Cambridge, Mass., 2–4 June. The display will be open to all scientists and purchasing personnel at 10 A.M. daily. More than 20 major scientific equipment manufacturers will display and demonstrate their newest instruments.

The U.S. Atomic Energy Commission has authorized a nuclear power study by the **National Rural Electric Cooperative Association.** The association will finance the 1-year project, which will deal with the economic and engineering practicability of various atomic power reactor designs in relation to the specialized needs of the rural electric systems. This would include a study of the reactors to be constructed and operated in the AEC's 5-year research and development program, the Army Package Power Reactor, and any other experimental power reactors that may be designed or built within the AEC program of industrial participation. The AEC will make available to a limited number of cleared personnel of the association technical data on reactor development and will arrange for visits to AEC laboratories and reactor installations.

Miscellaneous

"Dates of Stonehenge" by V. Gordon Childe is the lead article in the May issue of *The Scientific Monthly*. Since Stonehenge is the most celebrated prehistoric monument in Europe, Childe's article is of wide interest. Other articles in this issue are "Recent biological studies on *Teredo*—a marine woodboring mollusc," Charles E. Lane; "Ages at time of first election of presidents of professional organizations," Harvey C. Lehman; "Crops, weeds, and revolution," Jack R. Harlan; "Glimpses of the human side of Sir Isaac Newton," Henry P. Macomber; and "Middle-Atlantic geographic corridors," Richmond E. Myers. In honor of the 50th anniversary of the U.S. Forest Service, a brief history and a description of its activities are presented in the "Science on the march" section. Reviews of 19 books also appear in this issue.

The following **chemicals** are wanted by the Registry of Rare Chemicals, Armour Research Foundation of Illinois Institute of Technology, 35 W. 33 St., Chicago 16, Ill.: coronene; phenyldimethyl phosphine; 2,2,6,6-tetramethyl-3,5-heptanedione; 2,4,5-trichloraniline; dibromofumaric acid; 2,6-dimethylol-1,4-dioxane; 2,5-dimethylol-1,4-dioxane; δ-valerolactone; ethylarsenic diiodide; cyclohexylcarboxaldehyde; *p*-trifluoromethylphenylacetic acid; 1-(4-chloromercuriphenylazo)-2-napthol (sulfhydryl reagent); 3-mercaptopropionic acid; tris(*p*-methoxyphenyl)carbinol; tris(*p*-nitrophenyl)methyl chloride; methylene fluorobromide; 6-methoxy tryptamine; 3,3′-dimethyl-4,4′-diamino-1,1′-dinaphthyl; nitrosyl perchlorate; nitronium fluorosulfonate.

In an effort to determine whether the monarch butterfly migrates, a Canadian museum is seeking the **help of American butterfly collectors.** F. A. Urquhart, director of Toronto's Royal Ontario Museum of Zoology and Paleontology, has written a letter to the Entomological Society of Washington, D.C., in which he explains that for the past 3 years museum workers have been attaching small gummed labels to the edge of the monarch's wing. The label informs the person finding a tagged butterfly that it should be mailed to the museum. The museum would like some help in both tagging and collecting, particularly from persons in the Washington, D.C., area.

The black-striped and orange monarch butterfly is considered by some to be the greatest wanderer in the butterfly world. It is reported to fly in large swarms from Canada to Mexico for the winter, and back again for the summer. One account of a swarm states that "in 1921 a swarm of monarchs 250 mi wide swept over Texas. It was estimated that 1,250,000 butterflies passed a given point every minute of daylight. And the flight continued for 18 days."

Erratum: In the issue of 25 March, page 433, the new book *Bibliography of Geology Theses, Colleges and Universities of the United States*, published by Petroleum Research Libraries, Denver, was incorrectly listed as available gratis. The price of the book is $8.

Book Reviews

Optics. Lectures on theoretical physics, vol. IV. Arnold Sommerfeld. Trans. by Otto Laporte and Peter A. Moldauer. Academic Press, New York, 1954. xii + 383 pp. Illus. + plates. $6.80.

Like the three volumes of Sommerfeld's lectures which have already been translated into English, this volume on optics (vol. 4) is an excellent treatise in many ways. Being a course of lectures, it is not a complete exposition of the subject of optics but rather is a careful treatment by means of the electromagnetic theory of a number of the most interesting topics. Thus it does not constitute a textbook in the ordinary sense, since it presupposes a very considerable background knowledge.

The electromagnetic theory is introduced in the very beginning and the mks system of units is used. This is rather unfortunate for those who were brought up to use, and who still like to use, the older systems, but it is probably more suitable for many of the students now studying theoretical physics. The Fresnel formulas for reflection from a dielectric surface are developed very early and are discussed fairly completely, as is also the subject of metallic reflection. With this background it is then natural for the lecturer to go into the theory of the Fabry-Perot interferometer. This he does in an unusual way, treating the problem as a boundary-value problem rather than as a problem in summation. This is a very elegant way of deducing the usual formulas but, as the text points out, it is restricted to the case of an infinite number of reflections. In Chapter II there is a discussion of the optics of moving media, and the theory of relativity is introduced at this point. The discussion of the Michelson experiment is particularly simple. In Chapter III the lectures on dispersion and magnetic rotation conform fairly completely to the classical expositions of these subjects. The discussion of the relationships of the phase, signal, and group velocities is valuable.

In Chapter V, Sommerfeld discusses the problems of diffraction and naturally does it particularly well, since this is a subject in which he has been a leader since 1896, when he was the first person to find a strict electromagnetic solution of a problem in diffraction. The various methods of approach to the problem are discussed, starting with the Huygens principle and going through Kirchhoff's solution and his own. Of particular interest is the portion of Chapter VI which deals with diffraction by a very narrow slit. This is a problem that Rayleigh solved for a certain range of values, but the approximations have been carried considerably further by Sommerfeld. The discussion of instruments, such as the grating, is not particularly original or complete, nor is the discussion of the Cornu spiral. In the last chapter there is a good general treatment of the resolving power, using a criterion slightly different from that of Rayleigh.

This book is not a textbook in optics but rather a source book for theoretical physicists in the methods applicable to optical problems. Like so many books written by theoretical physicists, its connection with experimental topics appears to be very tenuous but there can be no doubt that for an individual who has already made a study of optics from the point of view of the usual textbooks, such as Bruhat's *Cours d'Optique,* Sommerfeld's expositions are of great theoretical value.

A. G. Shenstone
Palmer Physical Laboratory, Princeton University

The Psychology of Invention in the Mathematical Field. Jacques Hadamard. Dover, New York, 1954. (Reprint of ed. 1 first published by Princeton Univ. Press, 1945.) xiii + 145 pp. Paper $1.25, cloth $2.50.

When this book, which is now reprinted in the Dover series on the history of science, first appeared in 1945, it was reviewed in many journals, chiefly nonmathematical ones. The consensus of these reviews (see, for example, *J. Philos.* **42**, 333) is that the book is gracefully and interestingly written, that it contains many important anecdotes, and that it will not help the reader to invent mathematics.

Sydney H. Gould
Department of Mathematics, Purdue University

The Theory of the Photographic Process. C. E. Kenneth Mees. Macmillan, New York, rev. ed. 1954. x + 1133 pp. Illus. $21.50.

Outside of a relatively small group of scientists and photographic technicians the complex theory behind the photographic process is little known. This theory has developed slowly and necessarily has drawn from the theoretical advances in nearly all other major fields of science. The photographic process as we know it today involves such studies as those of nonhuman animal products (gelatin), inorganic and organic chemistry, physics, mathematics, physiology of human vision, psychology, and perception. Perhaps no other comparably large industry as that built around the photographic process requires the coordinated efforts of so many specialized people for its success and growth. Just why the theoretical aspects of photography are not more widely known is difficult to answer, but certainly one important reason has been the scarcity of authentic textbooks on the subject, especially in the English language.

In 1942 when the first edition of Mees' *Theory* was published, this great need was partly fulfilled. However, no single textbook could be expected to treat such a scopic subject as the theory of photography completely. Nor could even a complete textbook be revised often enough to keep all its contents up to date. Yet, the first edition of Mees' book, followed by the present

second edition, has met these difficulties quite admirably. First, the subjects for presentation have been wisely selected. Second, the authors of the various chapters cover their subjects fully, but many details are left unsaid, which helps the reader to grasp an over-all picture of the underlying theory. Third, the extensive reference citations at the end of each chapter enable one to pursue any of the subjects in greater detail.

The second edition, although completely revised and largely rewritten, follows the general pattern of the first edition quite closely. One chapter in the first edition, "The photographic aspects of sound recording," has been omitted, but three new chapters have been added: "The action of charged particles on the photographic emulsion," "The latent image produced by x-rays," and "The sensitometry of color films and papers."

Another departure from the first edition is the appointment of special editors for each of the five main parts of the book—(i) "The photographic material," (ii) "The action of radiation," (iii) "Optical sensitizing," (iv) "Development and the after-processes," and (v) "The physics of the photographic process." Some 20 authors have collaborated in preparing the 25 chapters under these main headings.

Most of the discussion throughout the book has a theoretical slant, but many practical facts are included. Some of the chapters actually have more practical than theoretical value, which ties the text into the art of picture production and gives it wider applicability.

By way of criticism, it is my opinion that the research conducted by Kodak scientists has been overly stressed and in some instances original authors are not mentioned. There are very few typographic errors, and in nearly every instance such errors are obvious. For example on page 348 in the legend for Fig. 140 "radiant density" is used when it obviously should be "radiant energy." On the other hand, typographic errors such as the one on page 221 where the expression "the fromation of silver iodide" is used, near the bottom of the page, is likely to cause one to reach for the dictionary to see whether such a word as "fromation" really exists.

LLOYD E. VARDEN

200 East 66 Street, New York

Principles of Geomorphology. William D. Thornbury. Wiley, New York; Chapman & Hall, London, 1954. ix + 618 pp. Illus. $8.

Except for the omission of such subjects as dynamic geology, this textbook could easily be entitled "Intermediate physical geology." It is essentially an amplification of the material, usually covered in an elementary physical geology course, on weathering, mass-wasting, stream erosion and peneplanation, the arid cycle, eolian landforms, karstic forms, glaciation, oceanography, and volcanic and pseudovolcanic landforms. The two final chapters discuss sources of geomorphic information such as maps (topographic, geologic, soil, and climatic) and aerial photos, and practical applications of geomorphic reasoning and interpretation (as in engineering and military geology and in the location of ground water, ore bodies, and petroleum). Abundant references are included at the end of each chapter. Author and subject indexes are provided. Illustrations are numerous and excellent, and the format is very pleasing.

There are various features that distinguish this from some previous geomorphology textbooks. The devoting of an entire chapter each to submarine topography and "applied geomorphology" seems valuable. The introduction, almost at the beginning, of nine "fundamental concepts" (uniformitarianism; structure, process, and stage; complex origin of most landscapes; and so forth), which can be fully appreciated only after much further discussion but can well be kept in mind, is probably also worthwhile. Another valuable feature of the book is the reference in many places to the appearance on air photos of the features described.

With its many good qualities, the book unfortunately is poorly written and contains many inaccuracies. Teachers might be well advised to read several chapters before deciding to adopt it as a textbook.

CHARLES R. WARREN

U.S. Geological Survey

The Alkaloids: Chemistry and Physiology. vol. IV. R. H. F. Manske and H. L. Holmes, Eds. Academic Press, New York, 1954. x + 357 pp. $8.50.

This volume is devoted to the chemistry of the alkaloids of the isoquinoline type, in 11 authoritative chapters, and further includes two sections on alkaloids of obscure or unknown structure, namely, the Erythrophleum alkaloids and those of the Aconitum and Delphinium groups. It represents the last volume on the chemistry of the alkaloids, except for a section on miscellaneous alkaloids, which will be included in volume V on pharmacology. It is intimated that a supplement may appear. This would be most welcome in view of dramatic synthetic developments in some of the most important alkaloid groups.

In this volume, the contributors have been chosen astutely for their competence in the several fields. In an introductory section, the biosynthesis of isoquinolines is discussed by Manske, with the conclusion that we do not know, but can speculate, awaiting confirmation with labeled atoms. The well-worn but physiologically interesting alkaloids of the mescal cactus are discussed by L. Reti (Buneos Aires), with a subordinate section on other cactus alkaloids. Here, as elsewhere, one is impressed by the unusually complete botanical documentation.

The simple benzylisoquinoline alkaloids, principally papaverine and its congeners in opium, are well reviewed by Alfred Burger (University of Virginia), an early worker in this field. Manske and W. R. Ashford (Merck, Montreal) present an exhaustive chapter on

protoberberine alkaloids (and berberine), with a strong botanical slant. With the aporphine and protopine types (both by Manske), more complex systems are introduced. The chapter on phthalideisoquinolines, by J. Stanek (Prague) and Manske, brings little new to the picture of this well-known group, mainly narcotine, hydrastine, and their conversion products.

Marshall Kulka (chap. 33) gives an excellent review of the complicated *bis*-benzylisoquinoline alkaloids, which includes the important curare group.

The concluding sections comprise the less-known cularine and alpha-napththaphenanthridine groups (Manske), the Erythrophleum alkaloids (G. Dalma, Buenos Aires), and a difficult section on the Aconitum and Delphinium alkaloids (E.S. Stern, McFarlan Co., Edinburgh).

There are a few inconsistencies. In some places, physical properties of important derivatives are missing, in others detailed instructions are given for the extraction of roots or leaves. These minor details do not detract from the value of the book to alkaloid chemists.

LYNDON F. SMALL

National Institutes of Health

Organic Analysis. vols. I and II. John Mitchell, Jr., I. M. Kolthoff, E. S. Proskauer, and A. Weissberger, Eds. Interscience, New York–London. vol. I (1953), viii + 473 pp. Illus. $8.50; vol. II (1954), viii + 372 pp. Illus. $8.50.

This new series is directed to the increasingly important field of organic analysis by functional groups. Each volume consists of a collection of nine monographs on selected topics, which fall into two categories. The first includes chapters devoted to the determination of specific functional groups. The first volume has eight chapters on the determination of hydroxyl, alkoxyl, alpha-epoxy, active hydrogen (two chapters), carbonyl, acetal, and sulfur groups. In the second volume are chapters on the determination of carboxyl; ester; nitro, nitroso, and nitrate; and active hydrogen and some oxygen groups by lithium aluminum hydride. Each chapter in this category gives an up-to-date review of the literature and explicit laboratory directions for selected procedures. The procedures have the added value of being the methods of preference selected from the now considerable literature by experts for use in their own laboratories.

The second group of chapters comprises discussions of newer instrumental and physical methods of organic analysis. In the first volume is a chapter on the use of spectroscopic methods for functional groups found in petroleum products. In the second volume are five chapters on coulometric methods, polarography, reaction-rate methods, phase-solubility analysis, and countercurrent distribution. The last two are sufficiently detailed to permit at least elementary application of the methods without further instruction. The other chapters in this category are more or less general reviews. They are stimulating and suggestive but would need to be supplemented by a study of the references in order to put the methods to practical use.

The work is well produced. There are a few inconsequential typographical errors. Although there is a difference in style among the various authors, the presentations on the whole are lucid. Where ambiguities occur they can generally be cleared up by further study of the text. There are good indexes, and volume 2 has a cumulative index for both volumes.

LYMAN CHALKLEY

5320 Middleton Lane, Washington 22, D.C.

Books Reviewed in THE SCIENTIFIC MONTHLY

May

Tobatí: Paraguayan Town, Elman R. Service and Helen S. Service (Univ. of Chicago Press). Reviewed by D. Bidney.

The Mathematical Practitioners of Tudor and Stuart England, E. G. R. Taylor (Cambridge Univ. Press). Reviewed by S. H. Gould.

Fresh Water from the Ocean, Cecil B. Ellis (Ronald Press). Reviewed by M. Telkes.

Archaeology in the Field, O. G. S. Crawford (Praeger). ***Archaeology from the Earth,*** Mortimer Wheeler (Oxford Univ. Press). Reviewed by J. B. Griffin.

Archaeopteryx lithographica, Gavin de Beer (British Museum). Reviewed by E. H. Colbert.

General Education: Explorations in Evaluation, Paul L. Dressel, Director (American Council on Education). Reviewed by W. C. Fels.

Motivation and Personality, A. H. Maslow (Harper). Reviewed by R. H. Knapp.

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Technical Papers

Anomalous Structure in the Hypocotyl of Soybean Following Treatment with 2,4-Dichlorophenoxyacetic Acid

C. N. Sun*

Institutum Divi Thomae Foundation, Cincinnati, Ohio

The effects of 2,4-dichlorophenoxyacetic acid (2,4-D) on the histological responses of certain plants have been described by various investigators. However, little response has been found in the pith cells of the hypocotyl region (*1*). This paper deals with the effects of 2,4-D in producing anomalous structures in the pith of the hypocotyl region of soybean seedlings (Monroe variety).

The seeds, after having been soaked for 24 hr in tap water, were transferred to moist blotting paper in Petri dishes for another 24-hr period. The seedlings were then immersed for 10 min in an aqueous solution of 2,4-D (500 mg/lit), after which they were cultured on moist blotting paper in Petri dishes and washed daily. The chloroplasts disappeared in the cortical parenchyma cells of the treated hypocotyl. The latter became yellowish and stunted but considerably enlarged in diameter. The four-winged broad shoulders developed throughout the entire region, owing primarily to the proliferation of the pericycle.

The pith cells of the hypocotyl region showed a very interesting response to 2,4-D. After 5 days of treatment, they started meristematic activity, the activity being greatest at the upper end of the hypocotyl. Only a few cells next to the primary xylem at the lower end of the hypocotyl divided at this stage. After 10 days of treatment, almost all the cells in the pith at any level within the hypocotyl had become meristematic. The pith cells proliferated and differentiated most rapidly directly beneath the cotyledons.

At the periphery, the active cell division resulted in the formation of a continuous, circular cambium layer from which vascular elements differentiated. A few derivatives centripetal to this cambium layer differentiated into tracheids and other vascular elements (Fig. 1, left). At a lower level, the cambium layer was irregular and curved along a random path so that it did not present a circular pattern in cross section. At the root end of the hypocotyl, dividing cells were observed in the pith, but no cambium layer was formed (Fig. 1, right). Pitted tracheids were present among the primary xylem elements and also in the vascular strands of the pith.

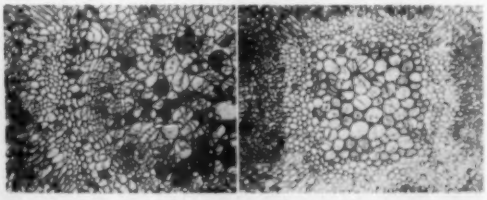

Fig. 1. Transverse sections of the hypocotyl region of soybean seedling after 10 days of treatment with 2,4-D. (Left) Transverse section at the upper end of the hypocotyl showing cambium and vascular strands in the pith. (Right) Transverse section at the root end of the hypocotyl showing the dividing cells in the pith. (×46)

It is obvious that one of the striking responses of the soybean hypocotyl to 2,4-D is the tendency of cells to become highly meristematic; another response is the development of vascular strands in the pith. These responses show that differentiated cells retain their totipotential capacities following treatment. The 2,4-D apparently disrupts the orderly metabolic and physiological processes and, thus, leads to nonpolarized cell division and abnormal growth patterns.

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* Present address: St. Louis University, St. Louis, Missouri.

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21 January 1955.

Genetic and Nongenetic Effects of Radiations in *Neurospora*

V. W. Woodward* and C. M. Clark

Brookhaven National Laboratory, Upton, New York, and University of Delaware, Newark

The mechanism of radiation damage in biological systems eludes detailed description. It is concluded that, on the one hand, the lethal effects of x-rays are mediated entirely through the nuclei in *Neurospora* conidia (*1*), whereas, on the other hand, in barley (*2*) and *Habrobracon* (*3*), genetic (nuclear) damage alone cannot account for all the lethal effects of x-rays (*4*).

This paper (*5*) describes genetic and nongenetic effects of radiations in *N. crassa*, strain 74A-3b. The criterions used to detect radiation effects included genetic mutation, inactivation, and a "stimulatory" effect. The last criterion was measured as an increase in the number of conidia that germinated and as an accelerated growth rate following irradiation.

The mutation rate of one glutamic acid locus has been studied (*6*). The mutants were recovered according to the filtration and selective-plating technique (*7*). The observed mutation rate, expressed as mutants per 10,000 conidia, increased with x-ray dosage as follows: no dose, 0.85; 250 r, 0.93; 1000 r, 1.12; 2000 r, 1.03; 3000 r, 1.50; 7000 r, 3.05; and 10,000 r, 3.72 (Fig. 1).

Inactivation and the increase in the number of conidia that germinated following irradiation were measured concomitantly. Survival values of macroconidial populations were determined following expo-

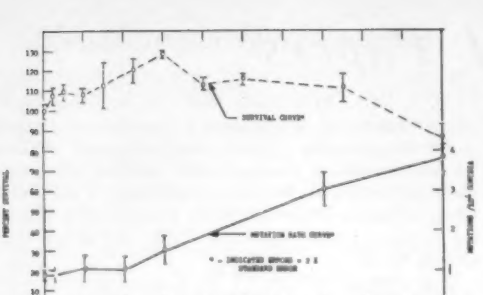

Fig. 1. Relationship of survival and mutation rate to dosage.

sures to relatively low dosages of x-rays; population sizes were determined by hemocytometer counts; and viability was determined by plating appropriately diluted aliquots of conidia onto minimal agar supplemented with glutamic acid (*8*). The number of conidia that germinated following irradiation increased with dosage up to 3000 r, at which dose between 20 and 25 percent more conidia germinated than in the untreated populations (Fig. 1). It is also evident from this figure that more conidia germinated following treatments of 250 to 7000 r than germinated without irradiation.

The second measurement of "stimulation" was that of a radiation-induced growth-rate alteration. Following irradiation, the conidia produced mycelia, in minimal medium (solution), that became perceptible to the naked eye at varying time intervals. By removing the developing mycelia (*7*), the duration of germination was measured. Unirradiated macroconidia produced mycelia in amounts sufficient to be perceptible in 15 to 20 hr at 24°C. The duration of germination was 24 to 36 hr. Conidia subjected to doses of x-rays or gamma rays between 500 and 50,000 r produced visible hyphae in 8 to 10 hr; the duration of incubation was 24 to 30 hr. Conidia treated with ultraviolet light or with thermal neutrons of varying doses were, on the contrary, retarded in growth. Perceptible growth was not detected until after 24 hr of incubation; and it continued at a rather constant rate for approximately 48 hr. There was a rather extended dose-independent range with all radiations. Since conidia one generation removed from the conidia treated with x-rays, thermal neutrons, and ultraviolet light and from untreated conidia germinated at the same rate, it was concluded that the stimulation was nongenetic.

It is evident from these data that x-rays effect changes in both genetic and nongenetic components of *Neurospora* conidia. X-rays affect the growth rate and the increased conidial germination similarly; but, in the case of the growth rate, either the biological component responsible is affected differently by the different types of radiation or different components are affected.

The relationship between mutation rate and conidial survival is more complex. The survival curve appears to be a composite of at least two independent events: (i) conidial "activation" or stimulation and (ii) inactivation. Therefore, it is difficult to determine the extent of either event, since a given survival value represents a combination of both. *A priori*, one would expect inactivation to be insignificant at low dosages, at which a rather large increment of stimulation occurs. At higher dosages, inactivation, no doubt, becomes more significant, but the increment of stimulation becomes difficult to measure. Since the survival curve is a composite, it becomes difficult to establish the correlation between either component and the mutation process. According to their relationship with x-ray dosage, stimulation is independent of genetic mutation; but, before the relationship between inactivation and mutation is established, it will be necessary to separate, experimentally, the two components that combine to produce a given survival curve.

The conidial "activation" caused by x-rays imposes certain difficulties to the interpretation of killing curves in *Neurospora*. Until the separate components are isolated, it would seem risky to attempt to separate nuclear from nonnuclear x-ray effects solely on the basis of existing killing curves.

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* Postdoctoral fellow of the National Institutes of Health, Cancer Foundation. Present address: Agronomy Department, Kansas State College, Manhattan.

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7 March 1954.

Liquid Sulfur Dioxide as a Solvent for Proteins and the Infrared Spectrum of Proteins in Solution

Joseph J. Katz

Chemistry Division, Argonne National Laboratory, Lemont, Illinois

Pure liquid sulfur dioxide (boiling point, −10.02°C) has previously been observed to have little or no solvent properties for proteins (*1*). In the case of water, it is well known that many proteins are insoluble in pure water but dissolve readily on the addition of small amounts of neutral salts (*2*). It has now been found (*3*) that a similar salting-in effect occurs with liquid sulfur dioxide, and that proteins are soluble in sulfur dioxide-neutral salt solutions.

Alkali metal (and ammonium) iodides and thio-

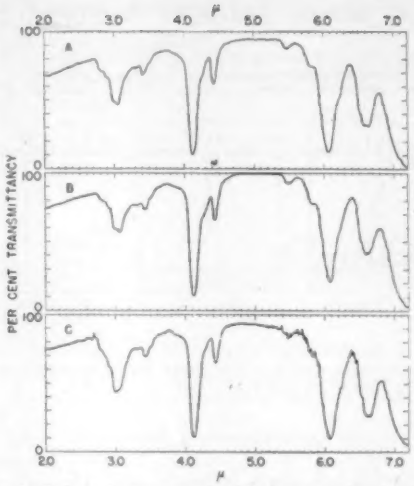

Fig. 1. Infrared spectra of globular proteins in 2.5*M* KI-SO_2 solution. Protein concentration, 10 mg/ml; cell thickness, 0.25 mm. (*A*) Insulin; (*B*) cytochrome *c*; (*C*) bovine gamma globulins.

cyanates are among the most soluble of the inorganic salts in liquid sulfur dioxide (*4*), and these have been successfully used as salting-in agents. The concentration of salt required to effect salting-in appears considerably greater in sulfur dioxide than in water. Nearly saturated solutions (at room temperature) of ammonium thiocyanate (6*M* NH_4CNS) and potassium iodide (2.5*M* KI) have been the most extensively used. Thus, bovine plasma albumin, bovine gamma globulins, insulin (*5*), crystallized egg albumin, trypsin, cytochrome *c*, urease, catalase, peanut protein globulin, zein, hide collagen, silk fibroin, and rattail tendon all dissolve readily in 6*M* NH_4 CNS-SO_2 solution. Nylon and poly-L-aspartic acid (*6*) are also soluble. Solutions with a protein concentration of 10 mg/ml have been prepared of all these proteins; the solubility limit is probably substantially higher for most of these proteins, and a solution of bovine plasma albumin of 100 mg/ml in 6*M* NH_4 CNS has been prepared.

These experiments were carried out on a metal vacuum line fitted with polychlorotrifluoroethylene reaction tubes; this made it possible to prepare and observe these solutions at room temperature. Sulfur dioxide-potassium iodide solutions are not as powerful solvents as are the ammonium thiocyanate-sulfur dioxide mixtures. Although many of the proteins listed in the foregoing paragraph dissolve in 2.5*M* KI-SO_2, silk fibroin, collagen, nylon, and gelatin swell but do not seem to dissolve. As ordinarily prepared, protein solutions in SO_2-KI are red, and those in SO_2-NH_4 CNS are yellow; no visible changes in these solutions are noted after standing at room temperature for several days. Proteins dissolved in sulfur dioxide-salt solutions can be recovered by dilution; the addition of sulfur dioxide to reduce the concentration of the salt leads to the precipitation of the protein. The properties of the proteins recovered from such solutions still remain to be examined in detail.

It has been pointed out that there are certain advantages to the study of the infrared spectrum of proteins in solution (*7*) rather than as films or fibers. This has been, at best, a difficult task, since the usual protein solvents obscure at least a major portion of the infrared spectrum of the protein. With liquid sulfur dioxide as a solvent, the situation is greatly improved, since both the 3-μ and 6-μ regions are transparent (*8*); because potassium iodide is transparent in the infrared, the infrared spectrum of proteins dissolved in SO_2-KI solution can be readily studied.

Figure 1 shows the infrared spectra of dissolved insulin, cytochrome *c*, and bovine gamma globulins. The 3-μ and 6-μ regions are both clearly visible; the useful region extends to a little above 7 μ before the intense sulfur dioxide absorption sets in. These spectra were obtained at room temperature with a Model 21 double-beam Perkin-Elmer infrared spectrograph equipped with calcium fluoride optics and using a 0.25-mm cell (*9*). (The cell was not compensated, and two SO_2 peaks appear at 4 μ.)

The infrared spectrum of a bovine plasma albumin solution in the 6- to 7-μ region is shown in greater detail in Fig. 2. The infrared spectra so far obtained appear to resemble quite closely those of extended chain polypeptides described by Ambrose and Elliott (*10*). Particularly noteworthy is the shift of the 6.45-μ band to the vicinity of 6.60 μ. This shift, which may be interpreted as the result of denaturation and unfolding, is not surprising in view of the known denaturing effect of iodide and the thiocyanate ions (*11*).

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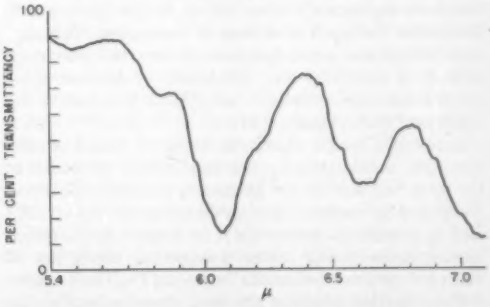

Fig. 2. Infrared spectrum of bovine plasma albumin in 2.5*M* KI-SO_2 solution in the 6-μ region. Protein concentration, 10 mg/ml; cell thickness, 0.25 mm.

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6 January 1955.

Auxin Gradient Theory of Abscission Regulation

F. T. Addicott, R. S. Lynch, H. R. Carns

Department of Botany, University of California, Los Angeles, and U.S. Department of Agriculture, Stoneville, Mississippi

Abscission of leaves, flowers, and fruits is known to be accelerated or retarded by many factors, including light intensity, photoperiod, temperature, water, mineral nutrients, carbohydrates, auxins, oxygen, carbon dioxide, anesthetics, mechanical injury, disease, insects, and senescence.

Several hypotheses and theories concerning the regulation of abscission have been advanced. Each has emphasized some important factor in abscission, such as turgor (*1*), nutrient balance (*2*), leaf-fruit ratio in fruit abscission (*3*), acidity (*4*), and hormone-ethylene balance (*5*). Few consider all known factors; none are adequately comprehensive. These hypotheses and theories will be analyzed in a forthcoming article (*6*). This paper reviews some aspects of the physiology of abscission and describes an auxin gradient theory of the regulation of abscission.

In an investigation of auxin in beans, Shoji *et al.* (*7*) found the concentration of auxin in the leaflets (distal to the leaflet abscission zone) approximately three times the concentration in the leaf stalks (proximal to the abscission zone). Shortly before the leaflets abscised, the auxin concentration in the leaflets fell, but in the leaf stalk it remained unchanged. This suggested that the auxin gradient across the abscission zone is a factor in the regulation of abscission. A similar but more extensive investigation in cotton has confirmed these results (*8*).

In excised leaflet abscission zones of beans, abscission was accelerated by the application of auxin to the proximal side of the abscission zone (*9*). This was confirmed in excised abscission zones of cotton (*10*) and in greenhouse beans (*11*). In *Coleus*, auxin transported from young leaves accelerated abscission of debladed petioles below the leaves (*12*). These observations further support the idea that the auxin gradient is a regulator of abscission.

Additional support is given by the auxin relationships of other factors affecting abscission: oxygen, which accelerates abscission, is required for auxin inactivation (*13*); under oxygen deficiency, abscission is retarded and auxin increased (*14*). Chemical defoliants lead to a rapid decrease in leaf auxin (*8*, *11*). Ethylene, which also accelerates abscission, decreases auxin in some species (although not in others) (*15*). Injury by disease or insects may reduce auxin; for example, the fungus *Omphalia* defoliates coffee, apparently through the production of an auxin-inactivating enzyme (*16*). Zinc deficiency, which often accelerates abscission, decreases auxin (*17*).

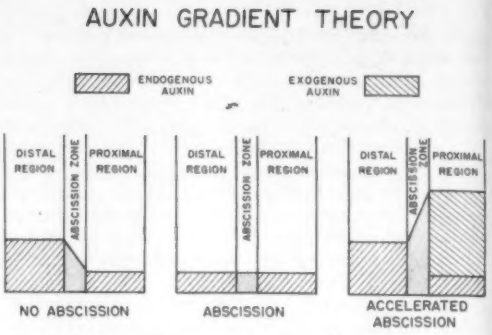

Fig. 1. Relationships between the auxin gradient across the abscission zone and abscission. Based on Shoji *et al.* (*7*) and Addicott and Lynch (*9*).

On the basis of this and other evidence (*6*), the following theory is proposed: Auxin is the principal endogenous regulator of abscission; its gradient across the abscission zone regulates onset and rate of abscission. Abscission does not occur with auxin gradients characteristic of healthy, mature tissue: with high auxin distal to the abscission zone and low auxin proximal to the abscission zone. Abscission occurs after a fall in the ratio of distal to proximal auxin. Abscission is accelerated when the gradient is reversed. Figure 1 shows these relationships. There is evidence of positive correlation between the auxin gradient and the rate of abscission (*10*).

Application of auxin to an intact plant frequently does not retard abscission (*18*), and may even accelerate it (*19*). On the basis of this theory, such results would be expected if applied auxin were translocated or inactivated as rapidly as it is absorbed, not enough remaining distal to the abscission zone to maintain a retarding gradient. If auxin accumulated on the proximal side of the abscission zone, the reversed gradient would accelerate abscission.

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4 January 1955.

Communications

Educators Sampled from an Undefined Population

"The most neurotic, as a class, are the scientists and our experience has been that biologists as a group exhibit more picayunish tendencies. . . . Professors of petroleum geology and other highly specialized engineering subjects sometimes seem to be plain downright ornery," writes Robert C. Cook, editor of the recently published 16th edition of *Who's Who in American Education* (*1*), on the second page of prefatory remarks referring to his editorial contacts with various educators during a period of 26 years. *Who's Who in American Education* is a companion volume to *Leaders in American Science*, concerning which Branson (*2*) has commented adversely. Perhaps *Who's Who in American Education* has certain characteristics that tend to disrupt the careful scientist's emotional balance and thereby lead to "neurotic," "picayunish," and "ornery" behavior.

Branson concluded that, because of errors and omissions, *Leaders in American Science* would have been more appropriately entitled "Some Americans Interested in Science." As a sequel to his note, we have attempted to estimate the coverage of *Who's Who in American Education*. There are five possible ways in which a person might be treated: current listing, including photograph (CP); current listing, no photograph (C); name listed, but reference made to a previous volume—that is, entry not up to date (L); name listed, but reference made to *Leaders in American Science* (LAS); not listed at all (N).

How fully are various populations of prominent professors of education, educational psychologists, and psychologists represented? First, we searched for the names of the 15 full professors working primarily in the department of education of the University of Wisconsin who do not have major administrative responsibilities. *Who's Who in American Education* does not list 12 of them (80 percent) at all; for two we were referred back to volume XIV (1949–50); only one person (7 percent) has a current listing, without photograph.

According to official records (*3*), there were 210 fellows of the division of educational psychology of the American Psychological Association on 1 Jan. 1954. They fall into the five categories outlined: CP, 7; C, 36; L, 22–15 (vol. XV), 6 (vol. XIV), 1 (vol. XII); LAS, 0; N, 145. Thus, only 43 entries, or 20 percent, are current. We cannot discern any basis for inclusion and exclusion. Such widely known professors as Yale's Carl I. Hovland, Duke's G. Frederic Kuder, Columbia's Irving Lorge, and Ohio State's Sidney L. Pressey are omitted altogether.

A third suitable population seemed to be the 207 members of the American Educational Research Association (*4*) who are full professors of education or closely allied fields, such as educational psychology and science education, and who do not have major administrative assignments. *Who's Who in American Education* gives current listing to 54 of these (26 percent), 18 with photographs. The 1953–54 AERA president, Guy T. Buswell, does not appear at all.

Last, we looked for the names of the 30 presidents of the American Psychological Association who were living when the 16th edition of *Who's Who in American Education* went to press, from O. Hobart Mowrer in 1954 to Robert S. Woodworth in 1914 (*5*). There are current listings for only four of them, or 13 percent.

From these searchings among prominent educationists and psychologists, it seems probable that, aside from listing an unstated percentage of certain types of school administrators described in its preface, *Who's Who in American Education* samples no definable populations of "educators." Despite the editor's assertion that "Volume Sixteen should contain the names of almost all of the superintendents of school systems in cities of 25,000 or more population," the two we sought (for Atlanta and Madison) were missing. Appearing in the volume are some classroom teachers ("You may be sure that any classroom teacher included in this volume was listed because he or she has been recommended by a responsible educator"); college teachers of all ranks, in nearly every conceivable field, and from many types of institutions; administrators at practically all levels; and noninstitutional educational workers of many types.

In his preface the editor complains that it is hard to locate the names and addresses of members and officers of various organizations, but this is certainly not true of the four populations we investigated. For example, all current members of the AERA are listed each year in the December issue of the *Review of Educational Research*, a widely circulated journal. Members of the American Psychological Association

and all officers from the beginning of the association in 1892 are listed in the official directories, published each year or two and available in many libraries.

It seems obvious that the volume would have to be at least five or 10 times its present length (1406 pages) in order to include all "eligible" individuals, for if one is to judge by the qualifications of persons listed, most employed educators, especially at the college level, meet its minimum requirements for "eminence."

JULIAN C. STANLEY
PEGGY THOMASSON

Department of Education,
University of Wisconsin, Madison

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17 January 1955.

Change in pK'_a of Representative Compounds with Solvent Composition

Determination of the apparent dissociation constant (pK'_a) by the potentiometric method is a useful tool in qualitative organic structural chemistry, in the estimation of molecular weights or purity of samples and as an adjunct to absorption spectrophotometry (*1*). In the course of these operations, samples are often found inadequately soluble in water for accurate titration, so that a solvent-water mixture is necessary.

The apparatus (*1*) works well with mixed solvents, generally to concentrations containing as little as 10 to 20 percent water. Below these concentrations, the system may behave erratically. The pK'_a values are usually modified in mixed solvents, depending on such factors as the solvent, the solvent concentration, and the nature of the dissociating group. These variations may provide additional information for the assignment of structure.

In order to use the change in pK'_a with solvent composition in group identification, it is necessary to know the expected direction and magnitude of the changes. These have been determined for a number of representative compounds with different solvents, for example, ethanol (*2*) and dioxane (*3*). In this study (*4*), ionization changes for compounds that are useful in the pharamaceutical field are examined in the alcohols and in two particularly effective solvents, dimethylformamide (DMF) and dimethylacetamide (DMA).

Techniques for titration, calculation, and determination of pK'_a have been described (*1*). In the preparation of mixed solvents, measured volumes of distilled water and of solvent were combined. Percentages refer to volumes of the pure components; thus, a 40-percent methanol solution was prepared by delivering 1.2 ml of methanol and 1.8 ml of water into the titration vessel. Solvents were checked for suitable physical characteristics and redistilled if necessary. The samples were commercially available materials of sufficient purity to yield satisfactory titration curves, selected to provide types of ionization common in structural identification work, individually and in combinations within the same molecule.

Results of the titrations, taken at a room temperature of 25°C, are shown in Figs. 1 and 2, in which the pK'_a is plotted against the concentration of organic solvent. The following observations may be made on these data.

All the acidic groups (carboxyl or phenolic hydroxyl) are greatly weakened by the addition of organic solvent. This is also characteristic of dibasic acids, where both groups show a large increase in pK'_a. The increase in pK'_a is generally greater with DMF and DMA than with the alcohols, and the smallest increase in pK'_a is with methanol.

Amine groups show comparatively little change in strength with change in solvent. In otherwise uncharged molecules, they are decreased slightly. In the zwitterion amino acids, the basic group or groups may be strengthened slightly in some solvents. Shifts in pK'_a with DMF and DMA tend to be greater than with the alcohols.

The response curves obtained with DMF and DMA indicate that these solvents are essentially interchangeable in titration experiments.

Although they follow these general trends, the curves of change in pK'_a with change in solvent do not behave in a uniform manner from solvent to solvent or between different compounds in the same sol-

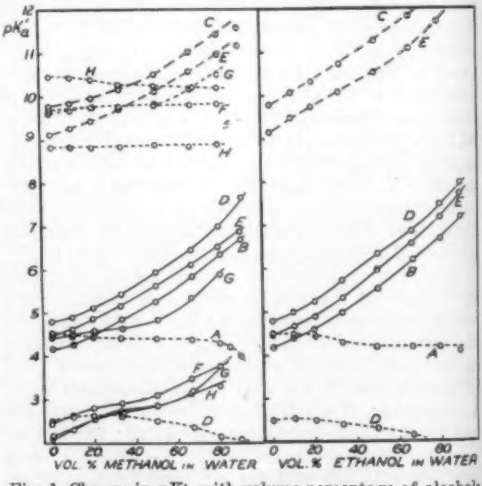

Fig. 1. Change in pK'_a with volume percentage of alcohols in water. Solid lines, carboxyl groups; dashed lines, hydroxyl groups; dotted lines, amino groups. The compounds titrated are identified by letters: (*A*) aniline; (*B*) benzoic acid; (*C*) phenol; (*D*) *p*-aminobenzoic acid; (*E*) *p*-hydroxybenzoic acid; (*F*) *dl*-alanine; (*G*) *l*-glutamic acid; and (*H*) *l*(+)-lysine.

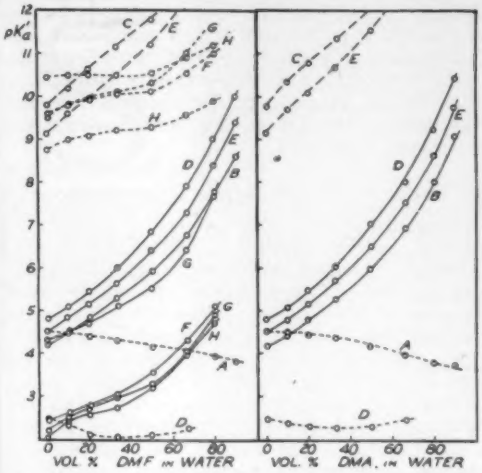

Fig. 2. Change in pK'_a with volume percentage of DMF and DMA in water. Solid lines, carboxyl groups; dashed lines, hydroxyl groups; and dotted lines, amino groups. The compounds titrated are identified by letters: (*A*) aniline; (*B*) benzoic acid; (*C*) phenol; (*D*) *p*-aminobenzoic acid; (*E*) *p*-hydroxybenzoic acid; (*F*) *dl*-alanine; (*G*) *l*-glutamic acid; and (*H*) *l*(+)-lysine.

vent. Plots of pK'_a versus log concentration of water in DMF yield a reasonably good line at the higher concentrations for aliphatic carboxylic and dicarboxylic acids, but such regularity is an exception.

Rigorous treatment of the factors that affect the values of dissociation constants in nonaqueous or mixed media is given in the literature (*5*). For empirical application of these measurements to qualitative organic structure analysis, it is not necessary to have complete knowledge of such factors, among which are (i) the change in hydrogen-ion activity and the consequent change in glass electrode response to concentrations of acid or alkali, (ii) the change in dielectric constant of the medium, and (iii) the change in solvation or hydrogen bonding of the ionizing groups. Interaction of these effects leads to nonuniformity of the plotted curves but does not interfere with their empirical use in determining the nature of dissociating groups.

J. M. VANDENBELT
CAROLA H. SPURLOCK
MARIAN GIFFELS
MARJORIE W. EASH

Research Laboratories,
Parke, Davis & Company, Detroit, Michigan

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16 February 1955.

More on Contemporary Science and the Poets

Apparently J. Z. Fullmer originally set out to discuss, in her article on contemporary science and poetry [*Science* **119**, 855 (1954)], the use of scientific terminology and references to technologic objects in poetry. Judging by her communication [*Science* **120**, 953 (1954)], one can assume that she did not intend that the subject should get so far out of hand as it did in the letters of Hagopian and Hirsch. The fatal error that led to this is contained in this statement in her letter:

> Questions about the function of the poet are different, not only in degree from the problem in "Contemporary science and the poets," but also in kind. They are in fact *sui generis*.

This error is the separation of form from content, which is a grave and fundamental error. Hirsch makes this same error in a most explicit and flagrant way:

> It is a misconception . . . to think that it is the task of poetry to interpret man's place in nature. This is the province of philosophy. The poet is preoccupied with images, form, and expression. . . .

Hagopian also tends toward this error, with his emphasis on "symbolic linguistic forms" and their use in the presentation of "human conative-affective experiences."

All three writers are caught in a fatal dualism—that is, the separation of the mind and the material universe into two incompatible and irreconcilable worlds. This leads them to compartmentalize human knowledge and experience to such an extent that Hirsch not only concludes that no real fusion is possible between poetry and science but that they will diverge even further in the future. Thus, we find it asserted that science does not deal with the fundamental questions of the universe, that poetry deals only with images and form, and that the symbolic forms of art and science are fundamentally different (Hagopian quoting Langer).

All these assertions are in basic error. Science must deal with the fundamental questions of the universe, and so must poetry! The real, material universe exists and is a basic reality. Human life and thought are a part of it and emerge from it. Thought is the result of the activity of an organized part of the material world, and the human brain is a reflection of, and in interaction with, this material universe.

It follows from this that Hinshelwood, as quoted by Fullmer, is incorrect in stating that science is

> . . . the attempt by the human mind to order these facts into satisfying patterns. Now a pattern or de-

> sign is not a purely objective function but is something imposed by the mind on what is presented to it. . . .

This is subjective idealism at its worst and must be rejected as a viewpoint leading to a blind alley instead of to progress. Rather, science is the attempt to reflect, in our concepts and formulations, as close an approximation of the true reality of the universe as is possible with the methods and theories of the day.

The task of science is not merely to learn more and more about the inexhaustible universe and then to order the facts learned into a pattern more and more closely approximating the true reality. Rather, the task of science is to *apply* these facts and theories in order to have greater control over our environment (and ourselves) for our social benefit, both materially and, *ipso facto*, spiritually.

Similarly, the task of the poet is not just to reflect reality, as a barometer, although this is a necessary precondition, but to interact with it and to give form, direction, and *content* to human relationships and aspirations as they relate to the real world. Poetry *must*—and here I dissent most vigorously from Hagopian and Morriss—make statements and judgments about values and *must* be partisan on the issues of the day, or be recognized by all as sterile pap and be promptly rejected. The poets of yesterday knew this. Did not the great, but nameless poets of the Negro spirituals make value judgments about freedom and slavery? Did not Whitman, Longfellow, and Whittier take the part of freedom and democracy in their poetry? Did not Kipling consciously apologize for British imperialism in India in his poetry? Did not Milton voice the position of the rising British middle class? They did, and each of them reflected the real world and interacted with it and expressed the viewpoint of some part of human society.

Do we sing the subjective poetry written only in lower-case letters, in isolated letters, and in typographical symbols? Or do we sing the Negro spirituals? The people know which is real and which is not, even if the "philosophers" do not. That some poet may discuss quartz prisms, and so forth, is indeed irrelevant if the terms are used only as forms and lack content and meaning.

Philosophy is not a separate discipline over and above science, poetry, or any other phase of human activity. Philosophy is the organization of knowledge of the real world into as accurate reflection of it as possible and the turning of this knowledge to the beneficial control of the universe. Into philosophy, then, go the findings of science, music, poetry, and so on. They are all integral, constituent, and interacting parts of the whole of knowledge and, therefore, cannot be incompatible and incapable of fusion.

As long as poets remain "vague, mystical, symbolic, antilogical"—that is, as long as they turn from reflecting, interpreting, and passing judgment on the real world and go instead into their own limited, subjective, form-sans-content world of "experience" divorced from reality—we will be plagued with this reactionary and dangerous dualism (because it departs from reality), compartmentalism, and consequent antagonisms between men.

H. DAVID HAMMOND
261 Harvey Street, Philadelphia, Pennsylvania

3 February 1955.

Hammond's aptest observation is that the discussion following "Contemporary science and the poets" has gone out of hand. The problem of that paper—to confront some modern poetry with contemporary science as a practicing scientist conceives it, with the hope of determining whether or not modern poetry contains the findings of modern science—from the outset excluded discussion of the function of the poet or the function of the scientist. These questions of function are interesting, but an author can hardly be guilty of a grave, fundamental error when he chooses to limit his attention to one clearly defined problem.

At the outset, too, my paper excluded from the discussion technologic objects mentioned in poetry as well as the isolated use of scientific terms; the assertion was not made "that science does not deal with the fundamental questions of the universe." Hammond's further statement that the "task of science . . . is to *apply* these facts and theories in order to have greater control over our environment . . ." stands on shaky ground. This view recently has been so devastatingly controverted by H. Dingle [*The Scientific Adventure* (Pitman, London, 1952), p. 7)] that it will not be discussed here.

Hammond's catalog of the great poets—Whitman, Longfellow, Whittier, Kipling, Milton, and the creators of the Negro spirituals—is certainly of interest. When the criterions by which the selections were made are examined, one is forced to the realization that their application would exclude the bulk of Shakespeare's poetic work, for instance, from the category "great poetry." Although catalogs of greatness are personal matters, the wisdom of such an exclusion strikes me at least as being dubious. (In this connection it may be mentioned that Hirsch's criterions, "vague, mystical, symbolic, antilogical," worked to exclude from consideration *De Rerum Natura*, which, he earlier inferred, belongs in the category of great poetry.)

Yes, Hammond observed correctly when he felt that the discussion of the problem in "Contemporary science and the poets" has gone out of hand.

J. Z. FULLMER
Tulane University, New Orleans, Louisiana

15 March 1955.

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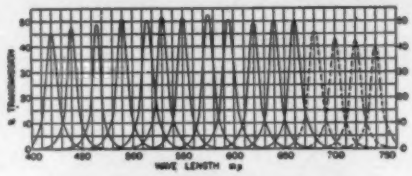

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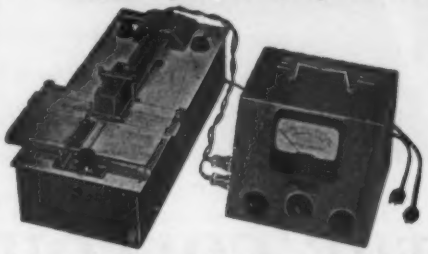

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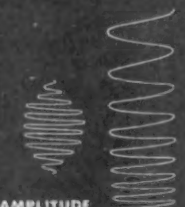

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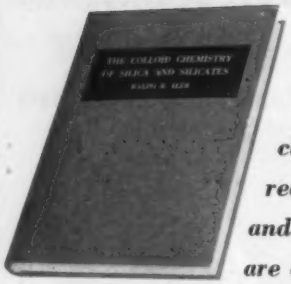

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Science and Policy

FOR some time, members of the American Association for the Advancement of Science have been bombarded, in the press and by mail, with arguments for or against the Upper Colorado project, and in particular the Echo Park Dam. This is a proposal to impound waters of the Colorado River for power and irrigation of arid lands. Proponents insist that it is essential to the growing economy of Utah and portions of Wyoming, New Mexico, and Colorado. The opposition contends that one of the dams will flood portions of a national monument, Dinosaur, thus violating a principle and establishing an unwholesome precedent. The project, they say, will be costly out of proportion to benefit. It will divert water now used and needed for activities in California where the water problem is already acute. Such diversion, it is argued, violates the legal principle of prior appropriation that prevails under Spanish law in our West. Even if the project were justified on its merits and in principle, opponents insist that alternative sites are available which would not invade reserved areas.

Supporting arguments add to the confusion. The respected senator from Utah, Arthur V. Watkins, denies that any infringement of national park lands is involved [*New York Times*, 29 March 1955]. The no less respected U. S. Grant, III, maintains the opposite view and, as an engineer, has investigated the situation, giving his judgment that the Dinosaur site is actually less desirable than others that are available. To this the Department of Interior counters with an unfavorable report on evaporation rates from other sites—and opponents question the figures presented.

Advocates urge that the project will enhance, rather than diminish, recreational values. Opponents cite the siltation and pollution that have impaired these values in Lake Mead. Again one side emphasizes the power and agricultural needs of the area to be benefited. The other maintains that only a limited proportion of the expense will be charged to power, and that the benefits to agriculture cannot be repaid out of income but must be underwritten by the nation, now plagued with crop surpluses. Tax figures, said to be reliable, show that the states to be benefited will pay less than 2 percent of the cost.

Costly and important as this whole issue may be, its greatest significance lies in illustrating a serious defect in our national structure as far as the relation of science to public issues is concerned. Scientific knowledge and personnel are available to present the American public with factual, verifiable information, thus stripping the issue down to essential questions of national policy. Public issues should not be clouded and confused by failure to get at the basic scientific facts. The role of science in a technologic civilization such as ours should be perfectly clear: to cut to a minimum the areas of uncertainty and dispute. The present claims and counterclaims concerning the effects of radioactive fallout from bomb-testing is another pertinent example [see Bertrand Russell, *Saturday Review*, 2 April 1955, with reassuring statements from other sources]. So are the divergent statements concerning our reserves of nonrenewable resources. Similar intolerable and costly conflicts are likely to be more, rather than less, frequent as life becomes more complex through population increase and the growing demands of technology.

The remedy is simple. It must become part of our habit of thought and a recognized procedure to insist that, in matters of public policy where verifiable physical knowledge is involved, such aspects of major problems be referred to impersonal, disinterested, and competent boards of scientists. We have, in the National Academy of Sciences and the National Research Council, a proper and legal mechanism for such assignments. These two closely interrelated groups have at their command the entire scientific talent of the nation. For various reasons, however, they cannot inject themselves into controversial issues, unless the Government or the public demands that they do so.

One group of scientists has not shared this inhibition. The Engineers Joint Council has investigated and reported (unfavorably) upon the Upper Colorado project. But the air would be greatly cleared and an important principle established if the services of bodies representing all phases of science were called upon to analyze this and similar issues.

Failure to use science as a source of perspective in our present stage of culture degrades its function and may in time be disastrous.

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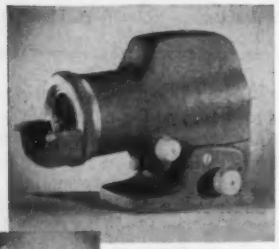

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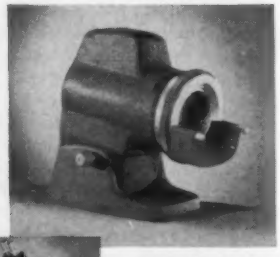

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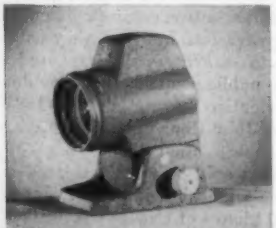

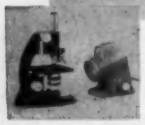

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30–3. International Hospital Federation, 9th cong., Lucerne, Switzerland. (J. E. Stone, 10 Old Jewry, London, E.C. 2, England.)

June

1–4. Alaskan Science Conf., 6th, College, Alaska. (Arthur S. Buswell, Box B, College.)

2–4. National Soc. of Professional Engineers, annual, Philadelphia, Pa. (K. E. Trombley, NSPE, 1121 15 St., NW, Washington 5.)

3–4. American Rheumatism Assoc., annual, Atlantic City. (W. H. Kammerer, 33 E. 61 St., New York 21.)

4–5. Soc. for Investigative Dermatology, annual, Atlantic City, N.J. (H. Beerman, 255 S 17 St., Philadelphia 3, Pa.)

5–10. American Soc. of Mechanical Engineers, Oil and Gas Power Conf., Washington, D.C. (C. E. Davies, ASME, 29 W. 39 St., New York 18, N.Y.)

5–11 Industrial Microbiology Inst., 8th annual, Lafayette, Ind. (C. L. Porter, Dept. of Biological Sciences, Purdue Univ., Lafayette, Ind.)

6–10. American Medical Assoc., annual, Atlantic City, N.J. (G. F. Lull, 535 Dearborn St., Chicago 10, Ill.)

6–10. Industrial Research Conference, 6th annual, Harriman, N.Y. (R. T. Livingston, 409 Engineering, Columbia University, New York 27.)

6–15. World Petroleum Congress, 4th, Rome, Italy. (General Organizing Committee, 4th WPC, Via Tevere 20, Rome.)

7. National Assoc. of Science Writers, annual, Atlantic City, N.J. (Rosamond R. Blakeslee, NASW, 5 Longview Rd., Port Washington, N.Y.)

8–10. American Meteorological Soc., Kansas City, Mo. (K. C. Spengler, AMS, 3 Joy St., Boston 8, Mass.)

8–18. International Organization for Standardization, Stockholm, Sweden. (American Standards Assoc., 70 E. 45th St., New York 17, N.Y.)

8–24. Joint Metallurgical Societies Meeting in Europe—London, Dusseldorf, and Paris. (W. H. Eisenman, 7301 Euclid Ave., Cleveland 3, Ohio.)

9–10. Carbon Conference, Univ. of Buffalo, Buffalo, N.Y. (Carbon Conference, Dept. of Physics, Univ. of Buffalo, Buffalo.)

9–21. Colloquium on Theoretical Physics, Ottawa, Canada. (T. Y. Wu, Div. of Physics, National Research Council, Ottawa 2.)

10–12. American Electroencephalographic Soc., 9th annual, Chicago, Ill. (W. T. Liberson, Veterans Admin. Hospital, Northampton, Mass.)

12–15. American Soc. of Agricultural Engineers, 48th annual, Urbana, Ill. (F. B. Lanham, ASAE, St. Joseph, Mich.)

12–16. Special Libraries Assoc., Detroit, Mich. (M. E. Lusius, 31 E. 10 St., New York 3.)

13–15. American Neurological Assoc., 80th annual, Chicago, Ill. (H. H. Merritt, Neurological Inst., 710 W. 168 St., New York 32.)

13–16. National Organic Chemistry Symposium, 14th, Lafayette, Ind. (W. E. Parham, 347 Chemistry, Univ. of Minnesota, Minneapolis 14.)

(See issue of 22 April for more comprehensive listings.)

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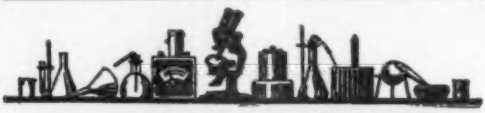

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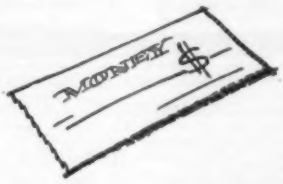

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